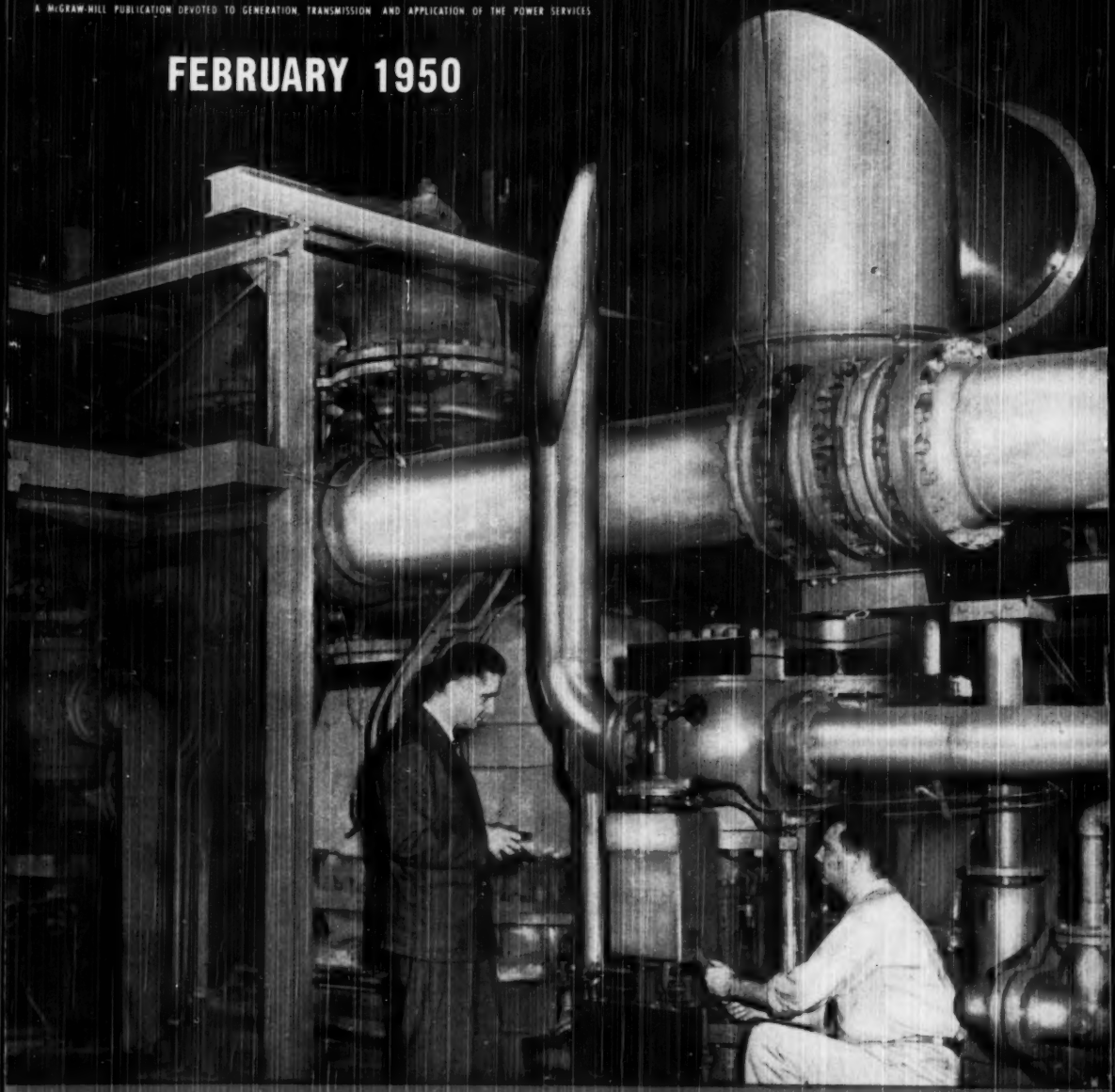
POWER

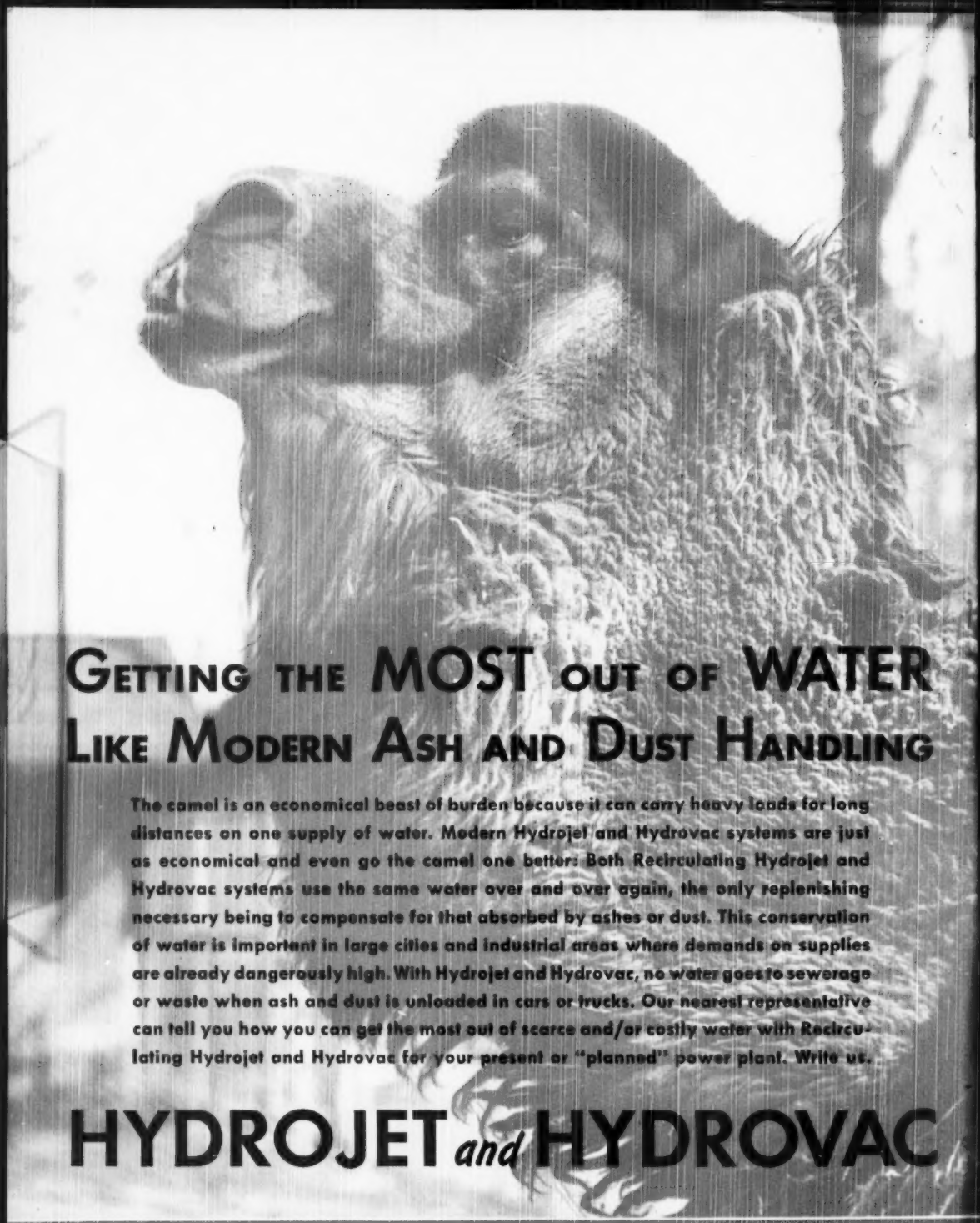
A McGRAW-HILL PUBLICATION DEVOTED TO GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES

MEASURING ELECTRICITY:
A SPECIAL SECTION, p 73

FEBRUARY 1950



GAS TURBINE BURNS COAL: Passing a major milestone in its program to bring the coal-burning gas turbine to reality, the Locomotive Development Committee of Bituminous Coal Research, Inc demonstrated full-scale handling and combustion equipment supplying an Allis-Chalmers Houdry-process turbine at the Dunkirk, N. Y. plant of American Locomotive Co. For a report of test experience on coal, see future issues. CONTENTS, p 69



GETTING THE MOST OUT OF WATER LIKE MODERN ASH AND DUST HANDLING

The camel is an economical beast of burden because it can carry heavy loads for long distances on one supply of water. Modern Hydrojet and Hydrovac systems are just as economical and even go the camel one better: Both Recirculating Hydrojet and Hydrovac systems use the same water over and over again, the only replenishing necessary being to compensate for that absorbed by ashes or dust. This conservation of water is important in large cities and industrial areas where demands on supplies are already dangerously high. With Hydrojet and Hydrovac, no water goes to sewerage or waste when ash and dust is unloaded in cars or trucks. Our nearest representative can tell you how you can get the most out of scarce and/or costly water with Recirculating Hydrojet and Hydrovac for your present or "planned" power plant. Write us.

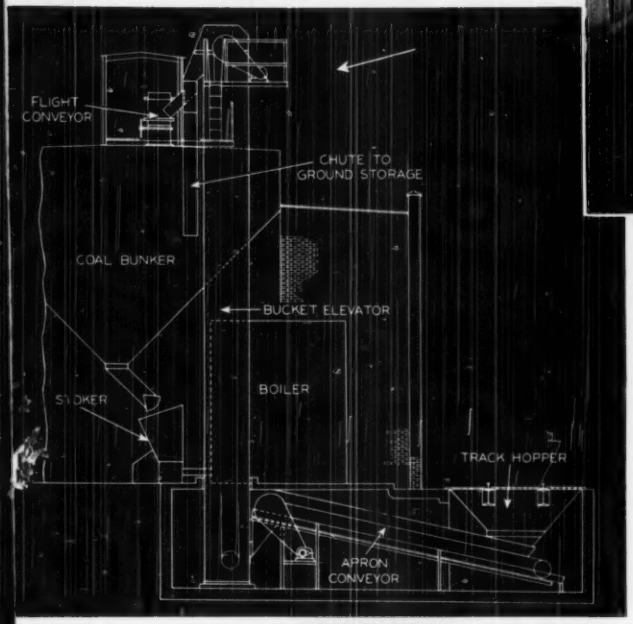
HYDROJET *and* HYDROVAC

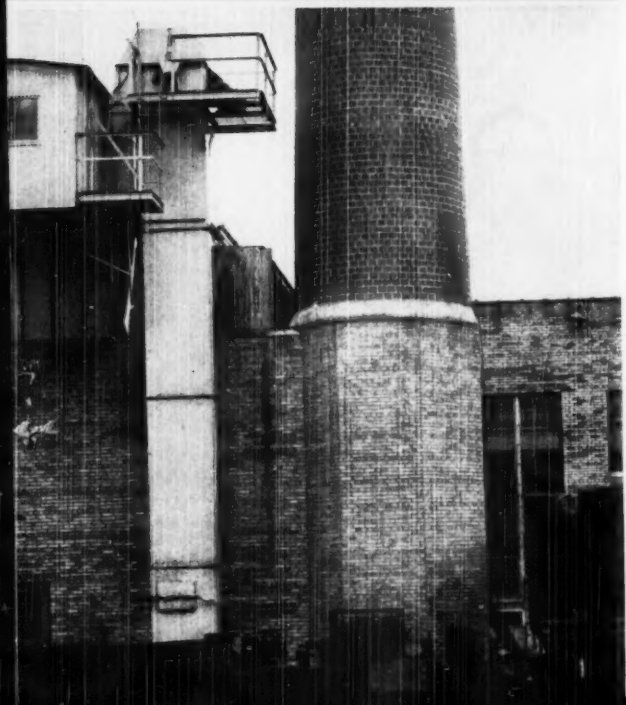
ALLEN-SHERMAN-HOFF CO., 227 S. 15th ST., PHILADELPHIA 2, PA. *Offices & Representatives in Principal Cities*

POWER (with which are consolidated "Science and Industry," "The Engineer Review," "The Engineer," "The Stationary Engineer"), February, 1950, Vol. 94, No. 2. Published monthly with an additional Directory number in June. McGraw-Hill Publishing Company, Inc. Editorial and executive offices, 330 W. 42nd St., New York 36, N. Y. Entered as second class matter January 26, 1949, at the post office at New York, N. Y., under the act of March 3, 1879. Printed in U. S. A. Allow at least 10 days for change of address. Subscription rates, U. S. and U. S. possessions, $5 for one year, $7 for two years, 65c per single copy. Canada, $6 for one year, $9 for two years. Pan-American Countries, $10 for one year, $16 for two years. All other countries $15 for one year, $25 for two years. Please indicate position and company connection on all subscription orders.

LINK-BELT

Coal Handling Installation Shows Advantages of *Small Plant Modernization*





LINK-BELT

Takes Own "Medicine"

The integrated Link-Belt coal handling system installed at the Link-Belt Speeder plant at Cedar Rapids, Iowa (where a complete line of power shovels, cranes, etc. are manufactured) again demonstrates that also in the smaller boiler rooms an investment in modernization pays for itself in higher efficiency, lower costs, greater capacity and other advantages.

Coal is stored in steel bunkers over the boilers. Combined capacity is 350 tons. Fuel is received by rail and unloaded into an undertrack hopper located adjacent to the rear of the boiler house. From the hopper the coal is picked up by an apron conveyor feeding a bucket elevator which takes it to the distributing flight conveyor serving the bunkers. If surplus storage is necessary, a chute at the top of the elevator can divert coal to a stock pile near the unloading hopper. The average capacity of a dump bottom car can be handled to bunkers or storage in about two hours.

Does your coal handling situation need a "tonic"? We have accumulated a vast store of experience designing coal handling systems for both large and small power plants.

TYPES OF LINK-BELT CONVEYING MACHINERY

Belt Conveyors	Apron Conveyors
Screw Conveyors	Oscillating Conveyors
Bulk-Flo Conveyors	Flight Conveyors
Chain Conveyors	Bucket Elevators
Trolley Conveyors	Bucket Carriers

LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities. 11,704

LINK-BELT

CONVEYING MACHINERY

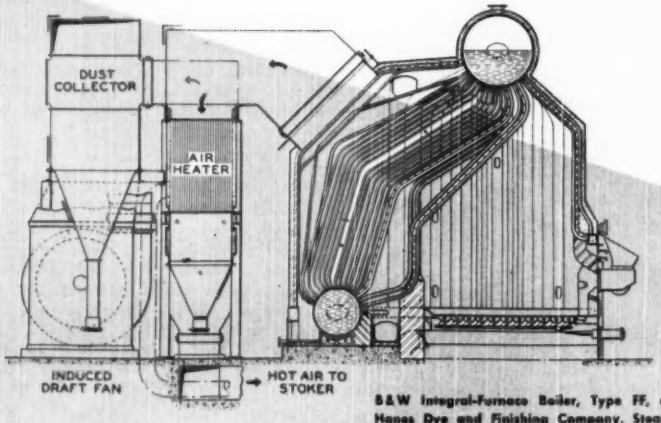
"THE COMPLETE LINE"

Another Example of B&W Engineering for Economy

...20% more steam
...37% less space
...20% fuel saving

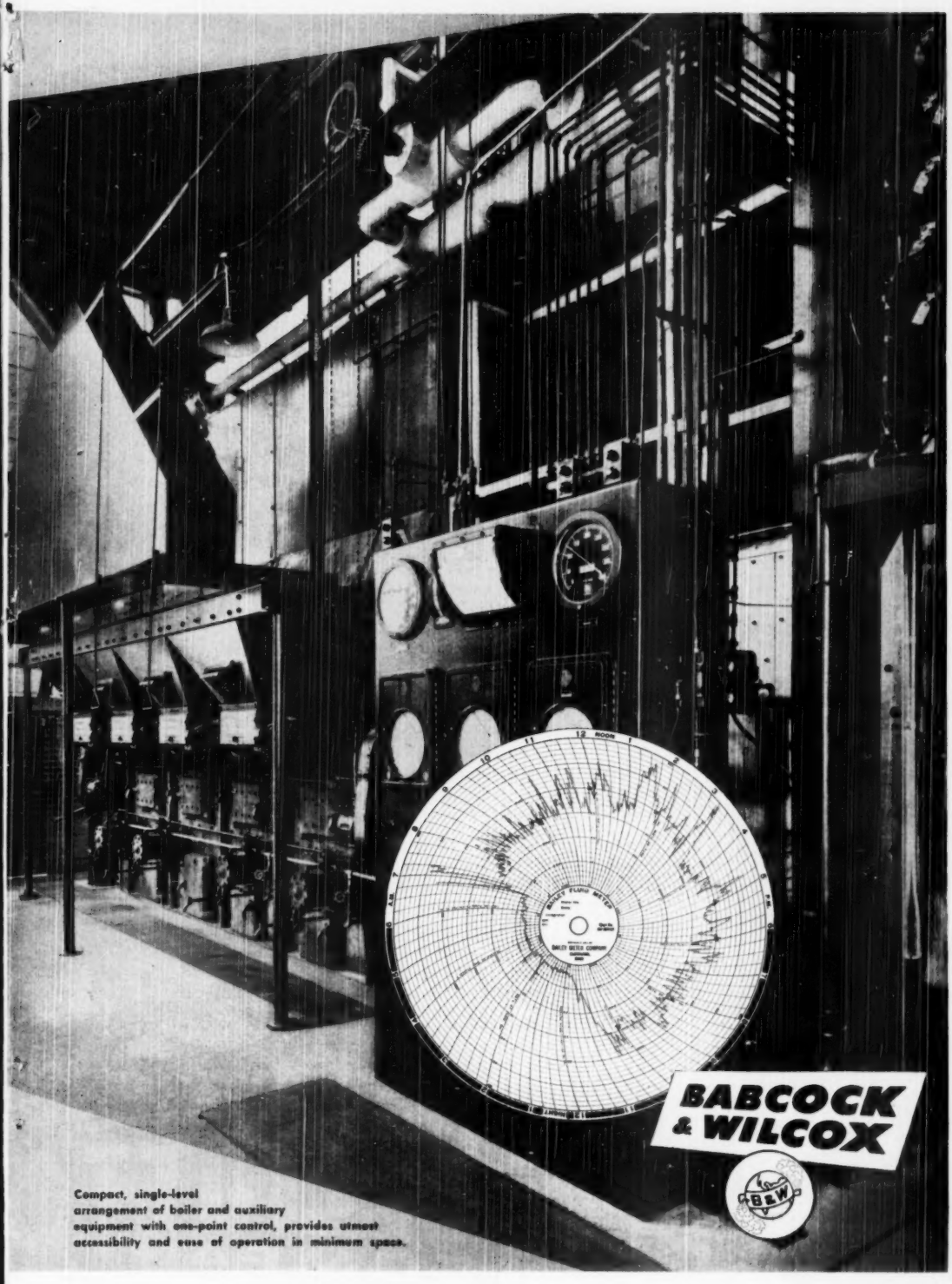
Hanes Dye and Finishing Company, Winston-Salem, N. C., recently installed a single spreader-stoker-fired B&W Integral-Furnace Boiler, Type FF . . . in 37% less floor-space than was occupied by four existing units having 1/5 less total capacity. High efficiency is maintained over a wide range of coals, including low grades, resulting in estimated fuel savings of 20%. Operating over a daily load range of 12 to 1, the new boiler easily handles instantaneous load swings of 5 to 1 with close control of pressure and steady water level, as compared to pressure drops as much as 40 psi in the old units. Heavy maintenance costs experienced with the previous installation have been eliminated.

Dollars and cents benefits usually follow B&W's participation in boiler modernization for *any* type of plant. It will pay you, as it has so many other industrial, commercial, and institutional users, to investigate the modern B&W Integral-Furnace Boiler, Type FF, for steam capacities up to 60,000 lb. per hr. Start by writing for Bulletin G-64. The Babcock & Wilcox Company, 85 Liberty Street, New York 6, New York.



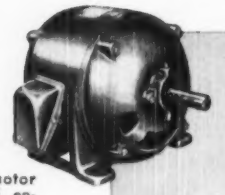
B&W Integral-Furnace Boiler, Type FF, at Hanes Dye and Finishing Company. Steam capacity is 40,000 lb. per hr. at 125 psi, with provision for future operation at 250 psi and with the addition of a superheater.

G-461



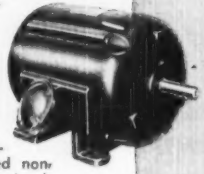
Compact, single-level arrangement of boiler and auxiliary equipment with one-point control, provides utmost accessibility and ease of operation in minimum space.

NOW IN MOTORS
IT'S ELLIOTT ALL THE WAY

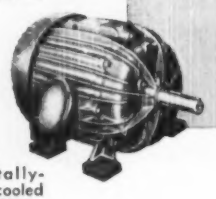


The BA protected-type motor has drip-proof enclosure.

The BA squirrel-cage splash-proof motor.



The BE totally enclosed non-ventilated squirrel-cage motor.



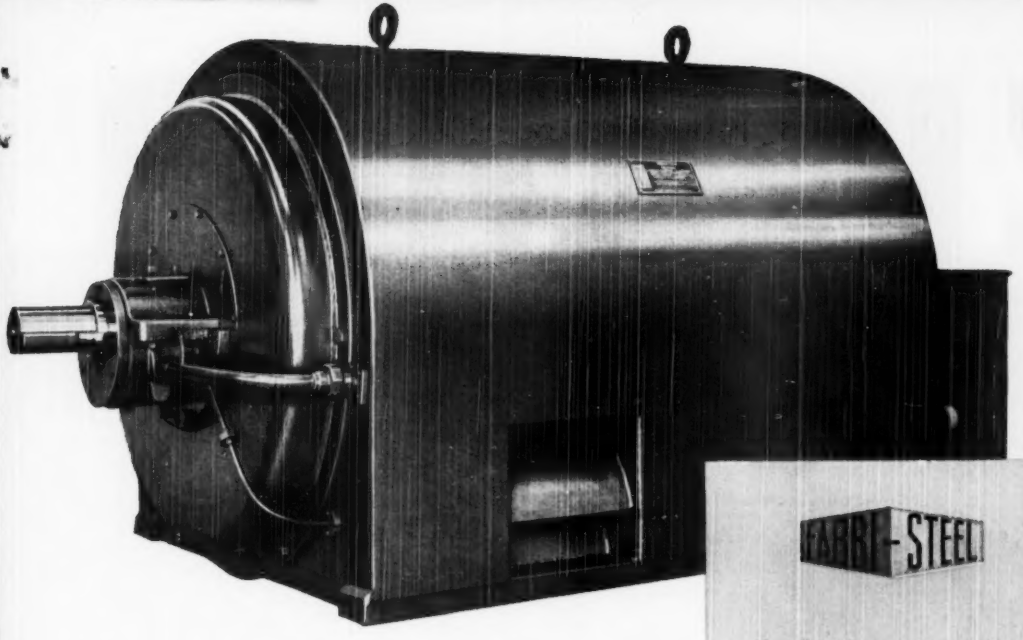
SEALED-POWER totally-enclosed fan-cooled motor (Form CFC).

This soundly established and complete line of motors includes practically every type and variation in small and medium-size motor listings. NEMA specifications and standards are rigidly adhered to.

The motors shown at left are typical C-W products. The BA line, squirrel-cage protected-type, has enclosures suitable for a variety of conditions in which drip-proof and splash-proof constructions are essential. The Form BE motors are totally enclosed, have no ventilating openings, and are cooled by surface radiation. Form CFC are the popular Crocker-Wheeler "Sealedpower" motors, completely enclosed. They are cooled by a constant stream of air blowing across the fins of a distinctive fin-type frame, which has 150% more heat-radiating surface than conventional fan-cooled motors.

For complete data on these and other motor types, write for bulletins.

ELLIOTT COMPANY



FROM 1 hp. -*up*

The Well-known CROCKER-WHEELER line of motors in capacities from 1hp up is now added to the equally popular ELLIOTT "Fabri-Steel" line of large motors in capacities from 250 hp up.

This means that under a single responsibility you can now get any motor you need from the smallest NEMA integral horsepower frame in a wide range of types, to the big, smooth-running all-steel Elliott motor that has made motor history during the past few years, replacing the familiar cast frame and bracket type motors of the past.

Make your motor problem an Elliott problem—talk it over with an Elliott motor engineer. Informative bulletins on request.

FABRI-STEEL

The all-steel construction of these motors together with a number of other Elliott developments, has set up new high standards of motor performance and operating economy, due to exceptionally rigid strength, general ruggedness and easy maintenance. The FABRI-STEEL two-pole induction motor, illustrated above, is typical of the line. It is available from 250 to 4000 hp, 3600 rpm, in types for normal or high starting torque and low starting current, easily accessible split-sleeve bearings, in various enclosures—drip-proof, splash-proof, enclosed, self- or separately-ventilated and with built-in coolers. The Fabri-Steel line also includes Elliott high-speed induction motors, 4 to 14 pole, 1800 rpm and slower, as well as high- and low-speed synchronous motors designed for specific service requirements, all with similar mechanical design and all-steel construction.

RIDGWAY DIVISION . . . RIDGWAY, PA.
CROCKER-WHEELER DIVISION, AMPERE, N. J.
Plants in JEANNETTE, PA. • RIDGWAY, PA. • AMPERE, N. J. • SPRINGFIELD, OHIO • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

E-798

CLEANER

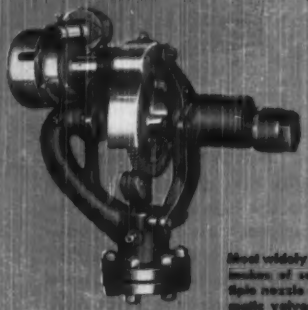
During 45 years of supplying most* of the soot blowers used in utility and industrial power plants, the Diamond Power Specialty Corporation has developed individual blowers for every soot cleaning requirement.

As a result, no matter what sort of blowing job you have, there is a Diamond Blower to fit it exactly. If you specify Diamond Blowers, there is no need to compromise . . . no need to use soot blowers that are inefficient for the particular job at hand.

Many more* installations means much more experience . . . consequently our engineers have acquired exceptional skill in the application of soot blowers. They know how to recommend blowers that result in cleaner boilers.

Some of the Diamond Blowers available are illustrated here . . . others are shown in Diamond Catalog No. 1014. May we send you a copy?

*For decades Diamond has sold approximately 80% of all soot blowers for power boilers.

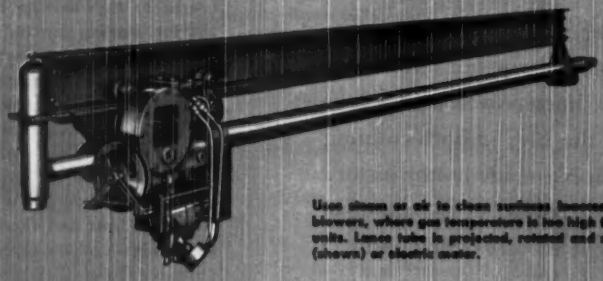


DIAMOND Model G9B Soot Blower

Most widely used of all types and makes of soot blowers. A multiple nozzle steam blower. Automatic valved . . . goes through complete operating cycle as the single chain is pulled or when driven by air (shown) or electric motor. Cam and trigger operation, flexible element connection and adjustable pressure control are important features.

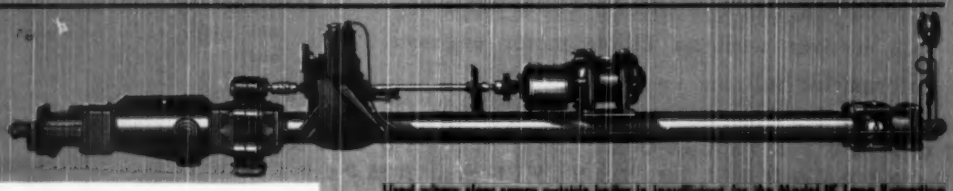
DIAMOND Model IS Short Retracting Soot Blower

Uses either air or steam as cleaning medium. For cleaning furnace walls or boiler heating surfaces in hot locations. Positive poppet-type valves prevent leakage and flow until nozzle is in blowing position; lubrication unnecessary; adjustable pressure control; few working parts. Operates by air (shown), steam, or electric.



DIAMOND Model IK Long Retracting Soot Blower

Uses steam or air to clean surfaces inaccessible to short retracting blowers, where gas temperature is too high for permanently installed units. Lance tube is projected, rotated and retracted by a single air (shown) or electric motor.

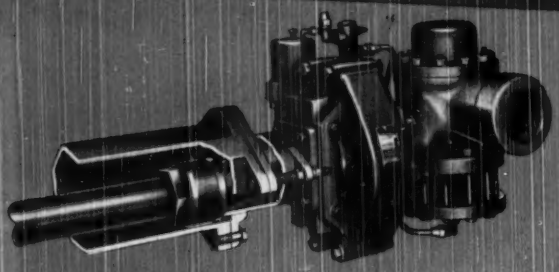


DIAMOND Telescopic Long Retracting Soot Blower

Used where clear space outside boiler is insufficient for the Model IK Long Retracting Blower. Standard 18-foot travel requires clearance outside boiler of approximately 12 feet. Built special for maximum travel of 20 feet with outside clearance requirement of about 14 feet. Special shorter models also available. Air or electric (shown) operation . . . uses steam or air as cleaning medium.

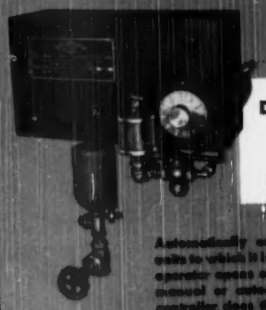
BOILERS

Because there is a DIAMOND SOOT BLOWER for Every Condition



DIAMOND
Model A2E
Automatic Air Puff
Soot Blower

Cleans automatically with series of compressed air puffs delivered through a standard multiple nozzle blowing element. During puff the element is automatically rotated through a small arc sufficient puffs are automatically provided to complete blowing arc. Spreading cleaning over longer period permits use of much smaller compressor and receiver—expels soot in small quantities—eliminates exact operating conditions.

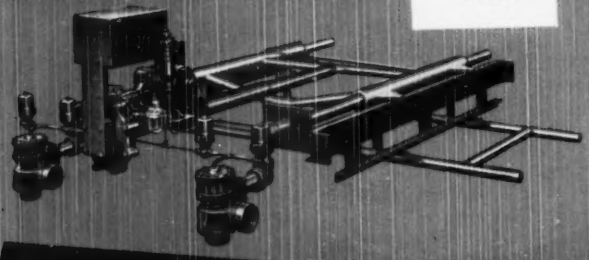


DIAMOND
Air Puff
Master
Controller

Automatically controls all A2E units to which it is connected. The operator opens one valve (either manual or automatic) . . . the controller does the rest . . . controls puff duration and interval, regulates element rotation, opens and closes air valves in head, determines sequence.

One or more multiple nozzle elements mounted on traveling frame. Elements traverse a straight line across tube sheet. Blowing medium is compressed air discharged intermittently and only when in register with tubes to reduce compressor and tank size. Air or electric operation—air or electric control, completely automatic.

DIAMOND
Automatic
Air Heater
Blower

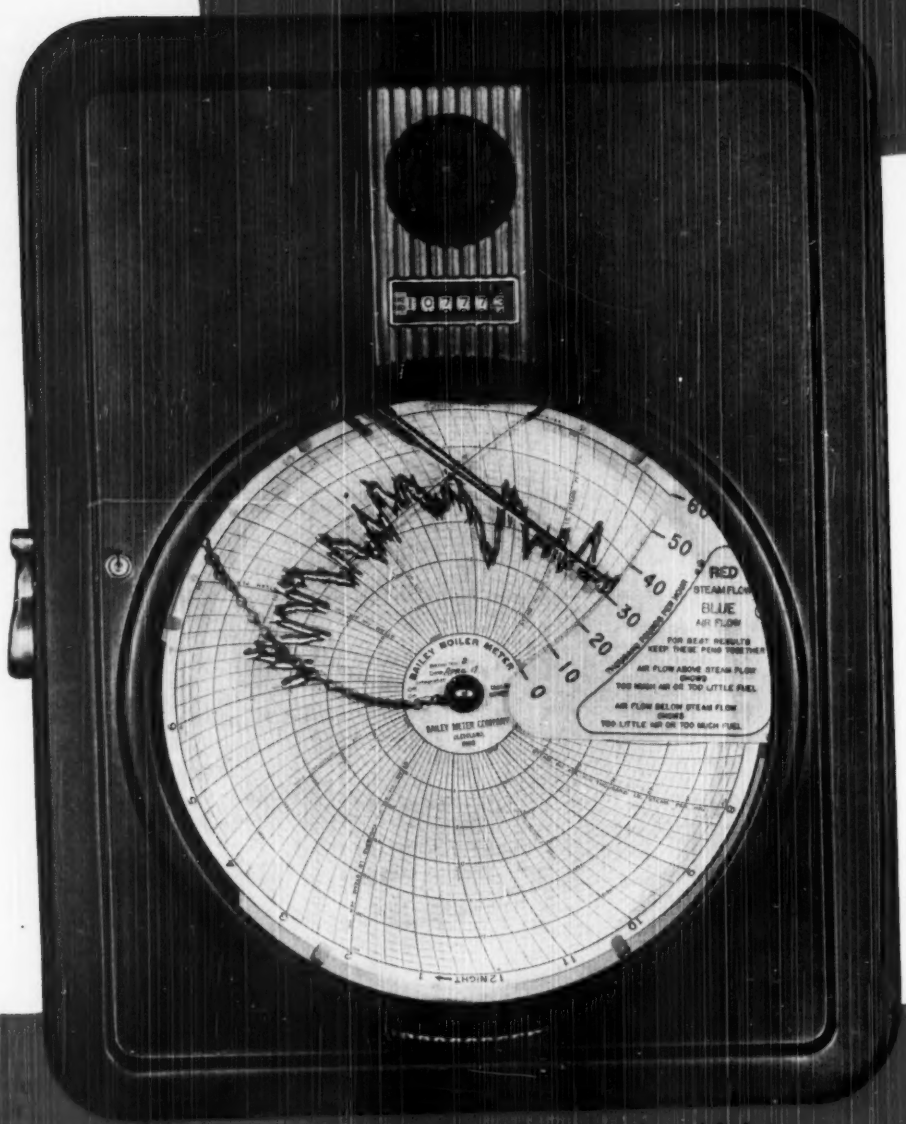


DIAMOND
Air Control
Panel

Controls automatic cleaning cycle of any arrangement of the various types of blowers. Operator starts cycle simply by moving start and stop valve carrier to the down position. Traveling upward it operates each selected unit or group in turn; shuts off when all cleaning cycles are completed. Shows at a glance the unit in operation and those that have operated. No electrical connections whatever.

DIAMOND POWER SPECIALTY CORP.
DETROIT 31, MICHIGAN
Diamond Specialty Limited • Windsor, Ontario

Whatever Fuel



Bailey Controllers of this type accurately measure and record the factors upon which controls are based.

You Burn—You'll Save Money with BAILEY CONTROLS

You'll get high Economy, Safety and Availability because Bailey Controls, working from the accurate measurements of Bailey Meters, do the right thing at the right time.

Bailey Combustion Control

1. Secures instant response to changes in load by regulating both fuel and air at the same time.

2. Maintains optimum fuel-air ratio as measured by Bailey Meters.

3. Gives you the same complete control, when you change fuel, or even when you burn waste.

Bailey Three-element Feed Water Control

1. Reacts quickly and yet retains high stability by accurately measuring Steam Output and Feed Water Input and by controlling the rate of feed water input so that it equals steam output.

2. Surge resulting from severe load changes is held to a minimum by the action of flow ratio and level components which may be adjusted to conform with boiler characteristics and operating conditions.

3. Needs no excess pressure control because its operation is based in part on an accurate measurement of feed water input.

4. Power used by feed pumps may be reduced by applying Three-element Feed Water Control directly to pump speed.

Bailey Steam Temperature Control

Maintains uniform temperature by controlling primarily from boiler load and by readjusting from temperature.

Bailey Feed Heater Control

1. Gives smooth efficient flow through heaters because its multi-element action incorporates accurate measurements of both flow and level.

2. Permits the use of smaller storage capacity heaters and tanks thereby reducing the cost of initial equipment.

Bailey Pump By-Pass Control

Protects pumps by opening a by-pass valve when flow through the pump drops below the safe minimum value.

BAILEY METER COMPANY

1036 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Steam Plants

COMBUSTION • PRESSURE
FEED WATER • LIQUID LEVEL
TEMPERATURE • FEED PUMPS

A-99

The ABC's of Powell Valve PERFORMANCE

Fig. 1303 W. E.—Class 1500-pound Cast Steel Gate Valve with welding ends, outside screw rising stem, bolted flanged yoke and tapered solid wedge.

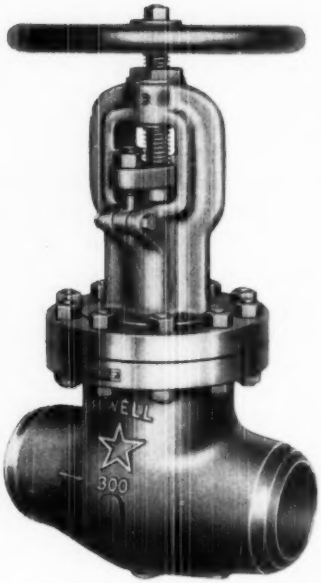


Fig. 3031 W. E.—Class 300-pound Cast Steel Globe Valve with welding ends, outside screw rising stem and bolted flanged yoke.

Fig. 500 — 125-pound Bronze Gate Valve with screwed ends, screwed-in bonnet, inside screw rising stem and tapered wedge; solid in sizes ¼" to ⅜"; double in sizes 1" to 3".

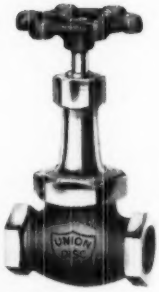


Fig. 150—150-pound Bronze Globe Valve with screwed ends, union bonnet and renewable composition disc.

POWELL

Always the right valve. And, because Powell *can* always furnish the *right* valve, you can avoid failures that result from trying to make a valve "do" in a service to which it is not *specifically* adapted, as well as those caused by misapplication.

Built to last. Powell Valves are designed for long life at a minimum cost of maintenance. The cost of construction and materials of any Powell Valve is determined solely by the requirements of the service for which the valve is designed.

Complete Line. Powell Valves are made in all types such as Globe, Angle, "Y", Gate, Check, Non-return and Flush Bottom Tank. Materials include not only Bronze, Iron and Steel but also a wide range of Corrosion-Resistant metals and alloys.

Ask your nearest Distributor—or write direct

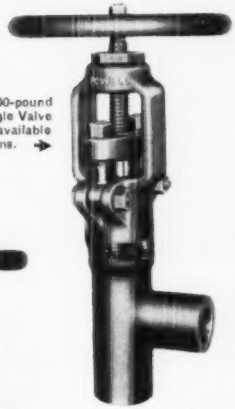


Fig. 1333-A—Class 1500-pound Steel Integral Bonnet Angle Valve with welding ends. Also available in Globe and "Y" patterns. →

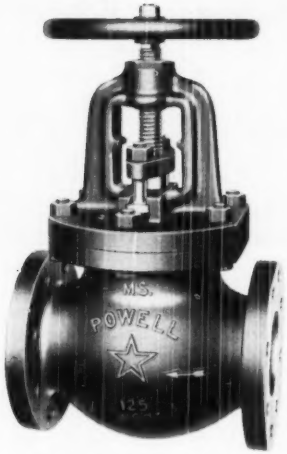


Fig. 241—Large 125-pound Iron Body Bronze Mounted Globe Valve. Sizes 2" to 16", incl. Has outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc.

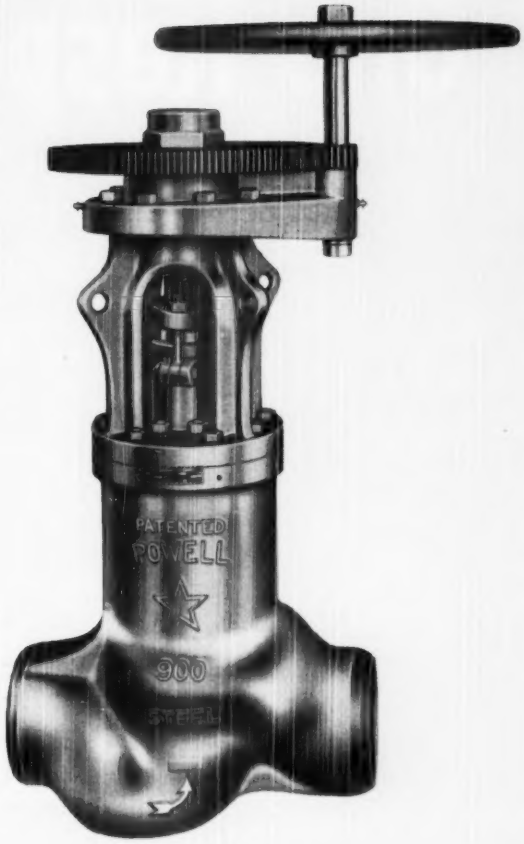


Fig. 1908A W.E.—Class 900-pound Cast Steel Pressure Seal Globe Non-return Valve with welding ends and spur gear operation. Improved streamline design reduces pressure drop and turbulence to the minimum.

The Wm. Powell Company

Cincinnati 22, Ohio

DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

VALVES

One Responsibility

THIS BARREL-TYPE BOILER FEED PUMP with reliable Allis-Chalmers 2-pole motor and control meets the demand for usual higher pressure requirements, 1200 to 2500 lbs; capacities from 300 to 2000 gpm. Each of the many individual features of this pump has been exhaustively tested and proved satisfactory for highest pressure requirements.

Back-to-back arrangement of stages and double volutes assure good axial and radial balance. ▶ Split inner casing simplifies maintenance. ▶ Main horizontal joint of inner casing uses full hydraulic discharge to keep joint in compression. ▶ Special design of this pump reduces possibility of flashing. ▶ Uniform metal section thickness throughout volute casing equalizes expansion.

Electrifugal is an Allis-Chalmers trademark.

Choose from *Complete* Allis-Chalmers Power Plant Pump Line, Including Motors and Control, and Save Time . . . Improve Equipment Coordination . . . Center Responsibility

BECAUSE Allis-Chalmers builds not only a complete line of power plant pumps, from boiler feed service to ash-handling, but the matching motors and control as well, it is able to take on responsibility for an entire power plant pumping "package." You gain three ways:

First, by consolidating selection and ordering you save time on engineering, pencil-work, etc. Second, your drives can be closely matched to pump requirements for most economical power. And third, you eliminate buck-passing, *know exactly* where to place responsibility should *any* component fail.

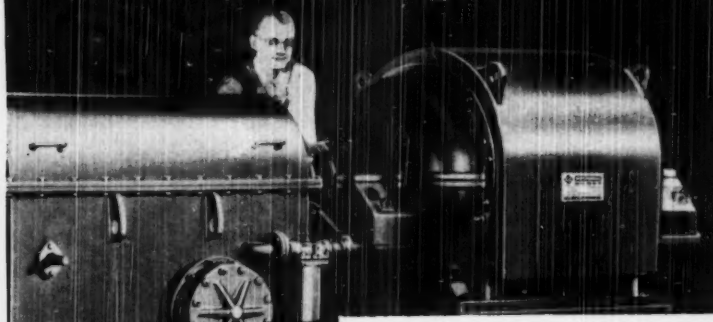
In the case of plants planning ahead, toward generation at the new, high steam conditions, this coordination is a "must."

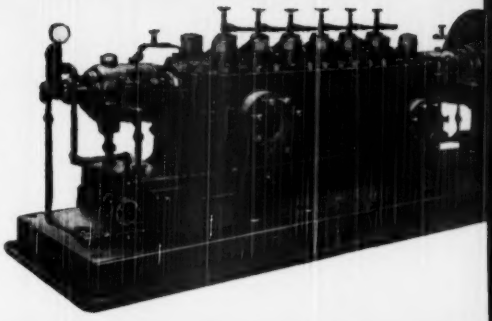
For plants now operating obsolete or inefficient pumps it offers a quick, sensible solution to the problem of bringing operating costs in line with industry standards.

There is a qualified Allis-Chalmers representative nearby who will be glad to get down to cases with you. Meanwhile, mail coupon at right for advance information on pumps in which you are interested.

ALLIS-

for Pump Performance!





Double Suction, Split-Casing Boiler Feed — a multi-stage, high head design built in all standard sizes. Standard pumps include casings of nickel cast iron with bronze fittings, or alloy steels where required. Volute casing assures smooth operation over a wide range of head and capacity.

OTHER ALLIS-CHALMERS PUMPS FOR POWER PLANT SERVICE:

Circulating—sizes to 100,000 gpm with moderate heads. 3 types: vertical axial flow; vertical mixed flow; horizontal and vertical centrifugal, Type S.

Boiler Recirculating — built to specification for the particular installation. Type of pump and requirements set by type of boiler.

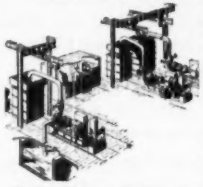
Condensate Removal — various types; horizontal and vertical designs.

Heater Drain—number of A-C pumps available in suitable types and sizes. Size of plant is determining factor.

Service, Wash Water, Evaporator Feed. For all cool, clear water applications A-C generally recommends Type S pumps.

Ash Handling—Type CW abrasive-resistant pumps recommended. 8 sizes, capacities to 10,000 gpm, heads through 140 ft.

NEW TEST FLOOR PROVIDES DATA ABOUT ALLIS-CHALMERS PUMPS



Motor speeds read to within less than one rpm. ▶ Water flow timed electronically, then weighed. ▶ The torque input to pump measured with electronic torsion meters. ▶ Possibility of "human error" removed. ▶ New floor aids in testing designs to build better pumps.

For many years A-C has maintained files of complete performance data on each pump built. Now, you are further assured of a completely mechanical precision check of pump performance.

A-2853

ALLIS-CHALMERS, 952A SO. 70 ST. MILWAUKEE, WIS.

Please send me information on your pumps for the following services:

_____

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NAME _____

TITLE _____

FIRM _____

CITY _____ **STATE** _____

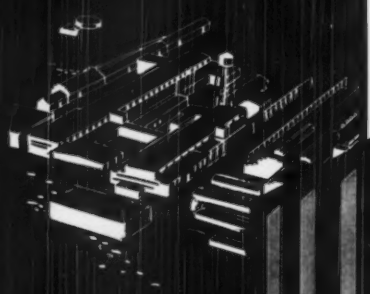
CHALMERS

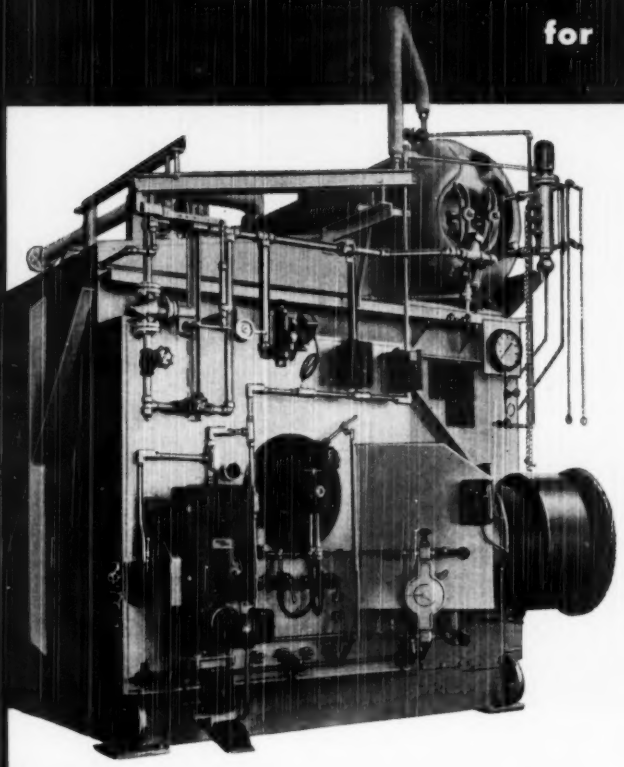
A-C ALLIS-CHALMERS

Water-tube Steam Generators

Foster Wheeler Package for

FROM FACTORY





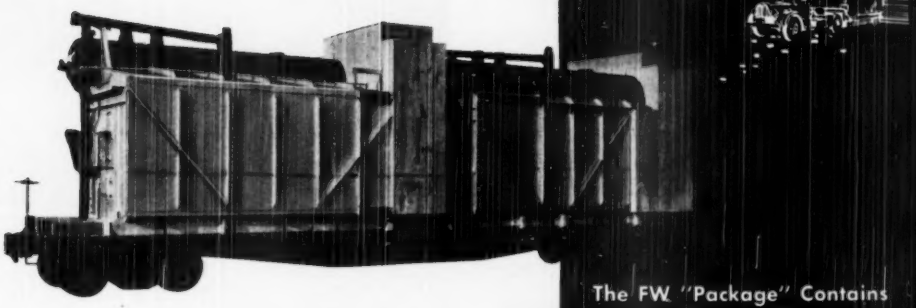
FACTORY ASSEMBLED STEAM PLANTS — Industry's need for small but efficient plants to supply power or process steam is fulfilled by Foster Wheeler *factory assembled water-tube steam generators* which can be shipped by common carrier, (truck, rail, or water) and readily installed. The labor necessary for installing a packaged unit is for the most part limited to service connections.

Foster Wheeler Package Steam Generators reflect the high engineering standards of an organization with over 50 years' experience in the art of steam generation and the manufacture and erection of power plant equipment. Therefore the purchaser of a Foster Wheeler Package Steam Generator is assured of skilled erection with proper assembly of any auxiliary equipment, high economy of steam production with any type of fuel, and efficient operation.

FOSTER WHEELER CORPORATION · 165 BROADWAY, NEW YORK 6, N. Y.

Assembled,—Then Shipped

Units up to 35,000 lb per hr
Coal, Oil, or Gas Firing



Write for a copy of Bulletin PG-49-13a which contains drawings, sizes, and descriptions of Foster Wheeler Package Steam Generators.

The FW "Package" Contains *All These Features*

- Completely Factory Assembled.
- Design pressures 300-500-900 psi.
- Simplified water cooled furnace construction with low furnace temperatures.
- Generous combustion chambers with low Btu release per cu ft of furnace volume for all types of fuel.
- Positive natural circulation.
- High thermal efficiency.
- Choice of manual, semi-automatic or fully automatic controls.
- Steel encased construction.
- Drums with large volumes—manholes at both ends—factory-applied insulation.
- Attractive exterior finish.
- Minimum heat loss from radiation and air infiltration.
- Sizes from 1500 to 35,000 lb per hr are plant assembled or field erected at customer's option.
- Sizes from 40,000 to 50,000 are field erected only.

FOSTER WHEELER

For Best Results: Install CRYSTOLON Brick in Boiler Furnaces

The drawings and explanation below are based upon recent installations of Crystolon (Silicon Carbide) brick in boiler furnaces. Results have been completely satisfactory when the directions given here were followed.

Crystolon brick best demonstrate serviceability where there is need of uninterrupted peak operation. Produced at high temperatures these brick are particularly resistant to extreme heat. Their hardness makes them resistant to the abrasive action of ash and the motion of the fire bed.

The surfaces of Crystolon brick are sufficiently dense to prevent molten ash from taking hold by penetration and this same density enables them to resist the erosive action of slag.

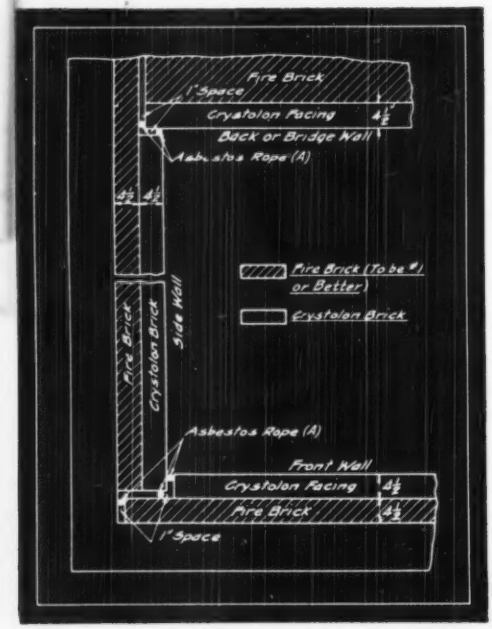


FIG. 1 *Typical Setting Showing Expansion Joints (A)*

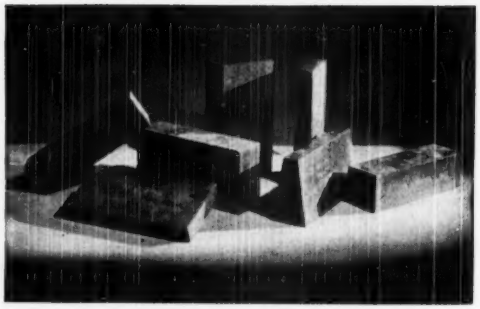


FIG. 2 *Crystolon Brick for Boiler Furnaces*

Other types of refractory brick often necessitate shutdowns or down-time to remove the clinker. While the clinker may sometimes adhere to Crystolon brick to a limited extent, these brick are sufficiently rugged to withstand the rather rough barring action that is commonly used to knock off the clinker.

Super refractory brick although costlier than ordinary fire brick actually give more economical service through reduced maintenance time and longer life.

It is advisable to use the same construction in the bridge wall as is shown (Fig. 1) for the side wall when Crystolon brick are used.

In cases where it may not be convenient to put in expansion joints as shown (see A, Fig. 1), expan-

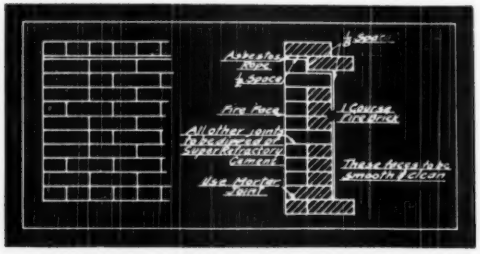

Asbestos Rope
Fire Face
All other joints to be filled with Super Refractory Cement
Use Header Joint
1 Course Fire Brick
Thoroughly wet, smooth & clean

FIG. 3 *Construction Using from 9 Courses up to 4' of Crystolon Brick*

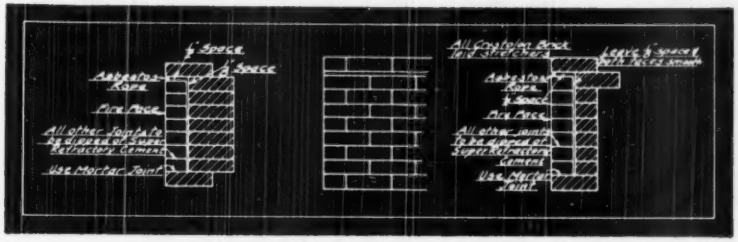

½ Space
½ Space
Asbestos Rope
Fire Face
All other Joints to be dipped in Super Refractory Cement
Use Mortar Joint
All Crystolon Brick Joints Shall be Dipped in Super Refractory Cement
Leave ½ Space
Asbestos Rope
½ Space
Fire Face
All other Joints to be dipped in Super Refractory Cement
Use Mortar Joint

FIG. 4 *New Construction (left) and Repairing Old Construction (right) Where 7 Courses or Less Are Used*

sion can be taken care of by leaving $\frac{1}{16}$" to $\frac{1}{8}$" open joint between each brick in the stretcher courses or every second brick in a header course. In any case, expansion allowances must be made. A good rule to use is approximately $\frac{1}{8}$" expansion to 15" of Crystolon brick in the wall.

For best results, not less than five courses of Crystolon brick should be used in any boiler furnace except in cases where exceptionally thin fire beds are carried and peculiar conditions of operation might justify the use of fewer courses.

In general, five to nine courses are used depending on the type of stoker, size of furnace, thickness of fuel bed carried and rating at which boiler is to be operated. If too few courses are used, there is danger of a slag curtain building down from the fire brick above and interfering with the efficiency of the Crystolon brick.

Always use a super refractory cement* for laying up the Crystolon brick. A dipped joint is best in laying Crystolon brick, unless otherwise specified. The brick should be hammered down tightly to make as nearly a face-to-face joint as possible. *Do not use ordinary fire clay or fire brick cements nor any of the groups known as air-setting or air-hardening cements in contact with the Crystolon brick.*

*Send for Norton Refractory catalogs: Cement No. 863-Crystolon Brick No. 862.

In the center retort, side-dump type of stoker the Crystolon brick should be started 3" below the nose of the dump plate.

In the multiple retort type of underfeed stoker the Crystolon brick should start at the grate line and follow the slope of the stoker, using a few more courses of Crystolon brick in the side wall toward the rear of the stoker. It is well to use standard lamb or bull nose and arch brick to build around the rear inspection door.

In the chain grate type of stoker the Crystolon brick should be laid directly on the side wall bed plate or in any case should start slightly below the top of the chain grate. In the case of one type of Cox stoker now in use a special Crystolon brick is employed with a $\frac{1}{2}$" cut-out which fits directly over the side wall plate.

In hand-fired boiler furnaces it is common practice to start the Crystolon brick an inch or two above the top of the grate.

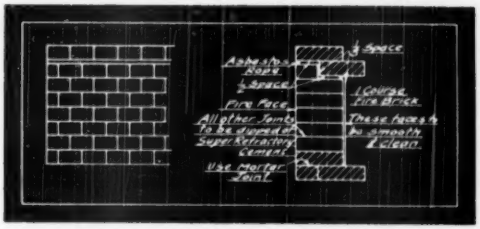

½ Space
Asbestos Rope
½ Space
Fire Face
All other Joints to be dipped in Super Refractory Cement
Use Mortar Joint
1 Course Fire Brick
These faces to be smooth & Even

FIG. 5 *Construction Using 9" Crystolon Wall All Headers up to 4' in Height*

NORTON REFRACTORIES LIKE HEAT
NORTON COMPANY - Worcester 6, Mass.

Macy's

San Francisco

gets

extreme flexibility

to handle load changes and future load growth

low installation cost

everything was shipped complete—as a unit—and easily installed

safety to personnel

no exposed circuits; metal encloses all current-carrying parts

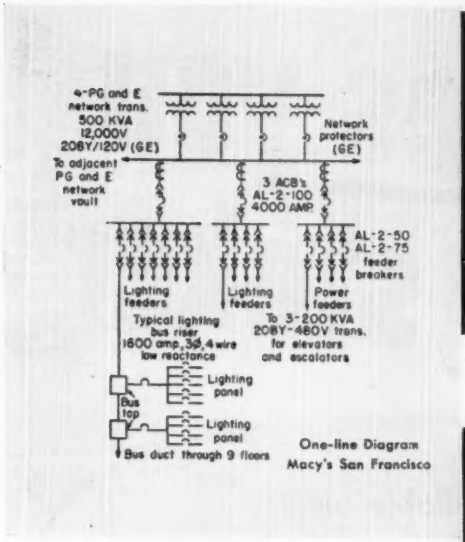
plenty of "IC"....with

10,000 amperes interrupting capacity, adequate to handle all short circuits

GENERAL ELECTRIC

HERE'S WHY . . . "In the department store business we cannot take any chances with power outages or potential fire hazards. We must also plan for expansion. That's why we wanted our power distribution system to be safe, to have adequate feeder and branch-circuit capacity, plus flexibility. General Electric switchgear gave us all these requirements."

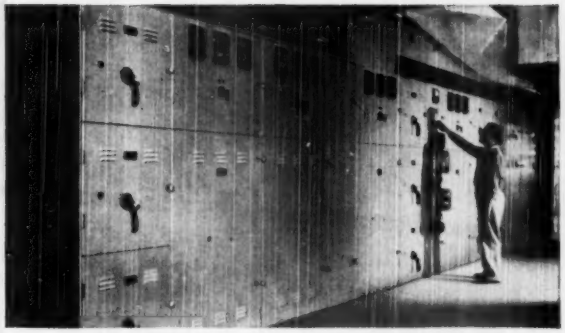
E. L. MOLLOY, VICE PRESIDENT
MACY'S, SAN FRANCISCO


To PG and E network trans. 500 KVA 12,000V 208Y/120V (GE)
Network protectors (GE)
To adjacent PG and E network vault
3 ACB's AL-2-100 4000 AMP
AL-2-50 AL-2-75 feeder breakers
Lighting feeders
Lighting feeders
Power feeders
Typical lighting bus riser 1600 amp, 3ϕ,4 wire low reactance
To 3-200 KVA 208Y-480V trans. for elevators and escalators
Lighting panel
Bus tap
Lighting panel
Bus duct through 9 floors

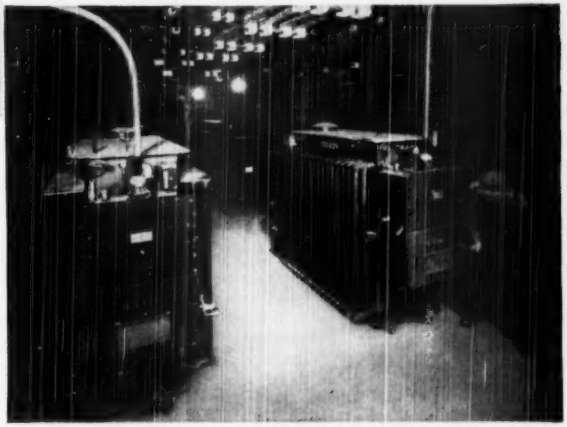
One-line Diagram
Macy's San Francisco

This, the largest switchgear installation to date in any San Francisco commercial building, adequately handles the power requirements that average four watts per square foot (nearly 500,000 square feet). Flexibility of the feeder system permits load changes without increasing the load on the switchgear. The 4000-ampere breakers have induction relay tripping.

Macy's installation is a complete General Electric project—switchgear, three 200-kva transformers for elevators and escalators, power and lighting panels, motors, and control for ventilating and boiler-room auxiliaries. One source of responsibility plus the very best in co-ordinated planning, engineering, manufacturing, and service facilities to give maximum savings and efficiency to the customer.



G-E metal-enclosed switchgear handles the incoming 120/208-volt power. The equipment is divided into three sections, two for lighting, one for power. Breakers (cascaded) are of the drawout type for ease of inspection and maintenance.



Four G-E network units, rated 500 kva, 12,000-120/208 volts in a Pacific Gas and Electric Company vault serve the building. Macy's 2500-kva load represents one of the largest loads added to PG&E's downtown network in recent years.

low-voltage SWITCHGEAR

Modern industrial power distribution systems using G-E switchgear are applicable to any industrial plant or commercial building where you want proper voltage for top performance of equipment, an extremely flexible setup to take care of expanding or changing loads, adequate short circuit protection, safety to personnel, and low installation and maintenance costs.

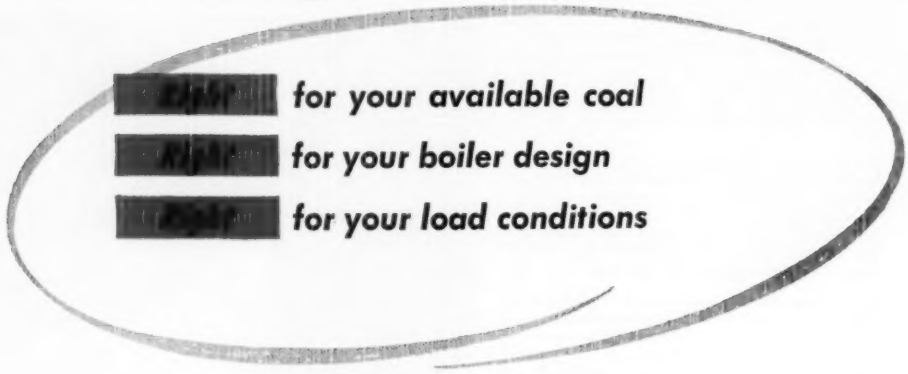
Be sure to see the "More Power to America" full-color sound slidefilm "Modern Industrial Power Distribution." Ask your G-E sales representative to arrange a showing for your organization.

Investigate today the many advantages of using General Electric switchgear in your plant for efficient, flexible power distribution. Contact your G-E sales representative for further information—and write for the helpful bulletins listed below. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GEA-4966 Low-voltage Switchgear
GEA-3642 Air Circuit Breakers
GEA-2017 Network Protectors
GEA-3083 Metal-clad Switchgear
GEA-3592 Load-center Substations
GEA-3758 Load-center Distribution

GENERAL ELECTRIC

C-E Assures you the right stoker



When you buy a stoker you want the type best suited to *your specific requirements.* You are sure of getting just that when you turn to Combustion Engineering-Superheater. Why? Because a background of more than 20,000 C-E Stoker installations (above residence size) makes available to you an accumulated experience unmatched by any other stoker manufacturer.

In addition, Combustion offers you the most complete line of stokers available today . . . a line that meets every requirement of fuel and load conditions. Therefore, as the manufacturer of *all* types of stokers, Combustion can give you impartial advice in helping you select the *right* stoker.

And at today's cost of coal, getting the *right* stoker can pay handsome dividends. For in an average installation the cost of coal used in a year exceeds many times the initial cost of the stoker. Thus the first cost of the stoker is soon absorbed by its saving in coal.

Typical of the complete C-E line are the three stokers on the opposite page — Skelly, Type E and Spreader. Each represents an outstanding value in its respective field. Each reflects the practical knowledge of fuels and operating conditions Combustion has gained through 60 years' experience in stoker design and application.

Day in and day out, all over the country, C-E Stokers are getting operating results as good or better than those anticipated at the time of purchase. In short, they are the *right* stokers for the job they were selected to do. So the next time you are in the market for stoker equipment, talk it over with Combustion before you buy. B-372

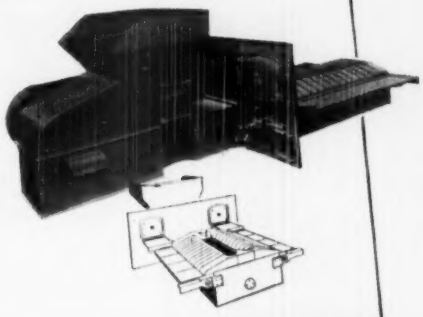
COMBUSTION ENGINEERING

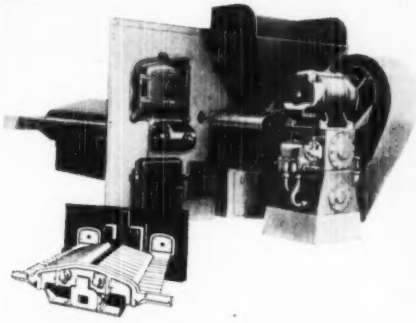
A MERGER OF COMBUSTION ENGINEERING COMPANY, INC. AND THE SUPERHEATER COMPANY

SKELLY STOKER UNIT

Approximate Application Range—20 to 200 boiler hp.

A compact, self-contained underfeed stoker available in designs for burning either anthracite or bituminous coal. An alternate arrangement of fixed and moving grate bars assures lateral distribution of fuel and maintains a clean porous fire. Cantilever dump grates of non-avalanching type simplify ash removal. An integral forced-draft fan, with inlet control, permits positive regulation of air-coal ratio. Sixteen rates of coal feed through variable-speed transmission. Automatic control is standard equipment. Timken bearing equipped. Alemite lubrication throughout.





TYPE E STOKER

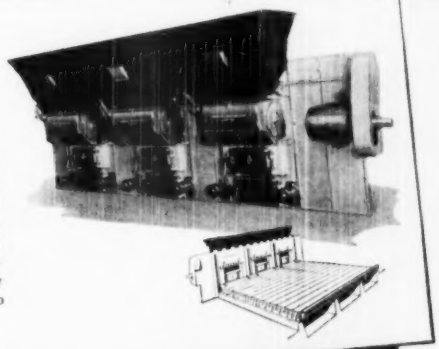
Approximate Application Range—150 to 600 boiler hp.

A single-retort, underfeed stoker designed to burn a wide variety of bituminous coals, particularly those having caking and coking characteristics. The Type E has ram type feed supplemented by a reciprocating sliding bottom. Its grate surface consists of hollow, air-cooled grate bars arranged in an alternately fixed and moving relationship to condition the fuel bed and assure its steady movement to the dump trays which are of the cantilever type. Air supply is under zoned control with provision for introduction of air over the fire. Type E Stokers are available with steam, electric or hydraulic drive.

SPREADER STOKER

Approximate Application Range—150 boiler hp. up to units producing 200,000 lb of steam per hr, or more.

The C-E Spreader Stoker is available in both dumping grate and continuous discharge types. This simple, rugged stoker is designed to burn a wide variety of coals. Hopper, feeding and distributing mechanism, variable-speed drive and motor are combined in a compact unit. Rotating spreader blades feed coal into the furnace in criss-crossing streams which assure uniform distribution. Fines are burned in suspension and the rest of the coal is burned on the grate. Grate surface is zoned for regulating air admission and to facilitate cleaning. All parts subject to wear are readily accessible for inspection, adjustment or replacement, when necessary. Rate of fuel feed and air supply may be regulated over a wide range and are readily adaptable to automatic control.

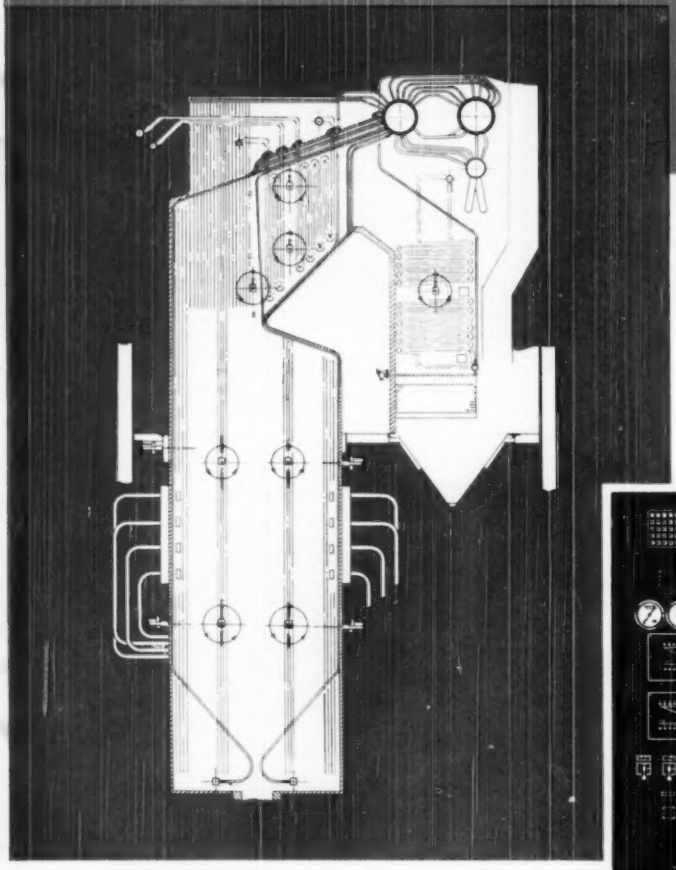


—SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

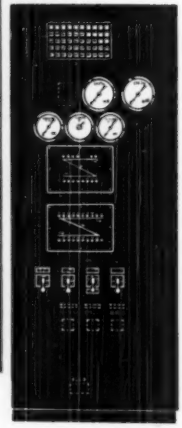
C-E

VULCAN at
Outstanding New



BOILERS:

Two Combustion Engineering-Superheater Steam Generators, each with a rating of 670,000 pounds per hour at 1492 psi and 1000 TST.



PANEL:

Automatic sequential operation of the entire Vulcan Soot Blower System is controlled from this central panel.

VULCAN *Automatic*

BUFFALO NIAGARA'S Dunkirk Station....

33 Vulcan Soot Blower units will be installed in each of Dunkirk Station's two 1492-psi C-E Steam Generators, including:

20—RW-1 Air-Motor-Driven Wall Deslaggers

8—T-2 Air-Motor-Driven Long Retractables

5—Air-Motor-Driven Vulcomatic Rotary Units.

Vulcan Automatic controls will also operate the Ljungstrom air preheater blowers.

Whether the blowing medium be air, as at Dunkirk, or steam —or both—the top design and operating engineers find in Vulcan's advanced engineering today's best buy for the really tough cleaning jobs.

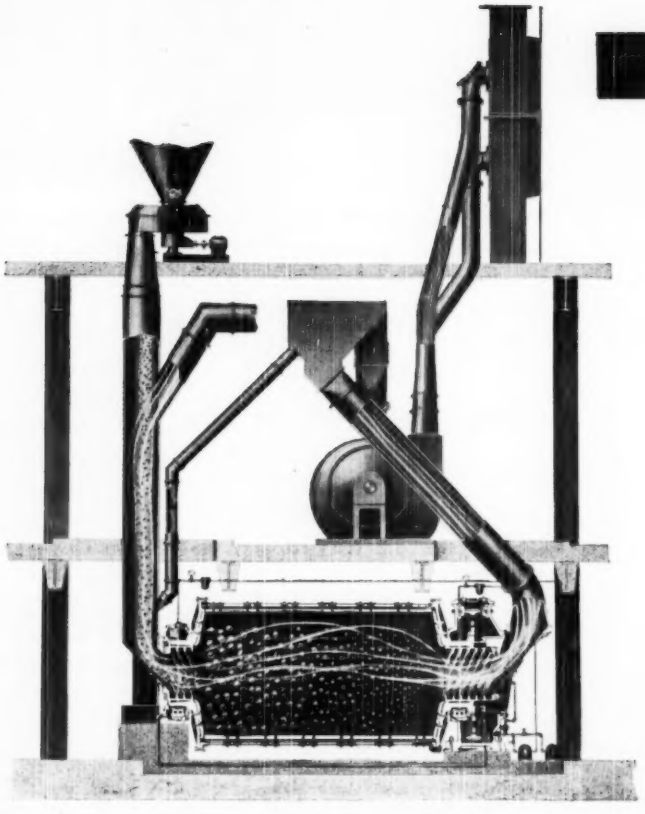
Write for Bulletin 483. It tells you how Vulcan Automatic Sequential Soot Blowers will keep your boilers clean, and cut your soot-blowing costs.

VULCAN SOOT BLOWER CORPORATION

DUBOIS, PENNSYLVANIA

Division of CONTINENTAL FOUNDRY & MACHINE COMPANY

KVS Engineered



PULVERIZATION
prepares Superfine Fuel for *Instant Response to Combustion Controls*

Air sweeping . . . by the direct inlet-to-outlet current of controlled quantity of . . . delivers air-coal mixture to the burners fast. From mill reserves of coal ground to pass 85% through 200 mesh, full capacity is available to meet heavy steam demand. Fluctuating loads are met easily. No coal is lost due to banking of fires at low load.

Coal unsuitable for other types of firing can be pulverized to an instantly combustible fuel in KVS Air Swept Ball Tube Mills. Coal, pulverized in air to KVS-recommended fineness, burns like a gas.

Coal containing from 5% to 15% moisture is direct fired. No magnetic separator is used. 99% availability . . . and better . . . contributes materially to low operating cost.

Ask for a copy of 97-page Engineering Bulletin No. 44-B containing valuable information on preparation of pulverized fuel and steam generating plants.

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MANUFACTURING AND ENGINEERING CORPORATION
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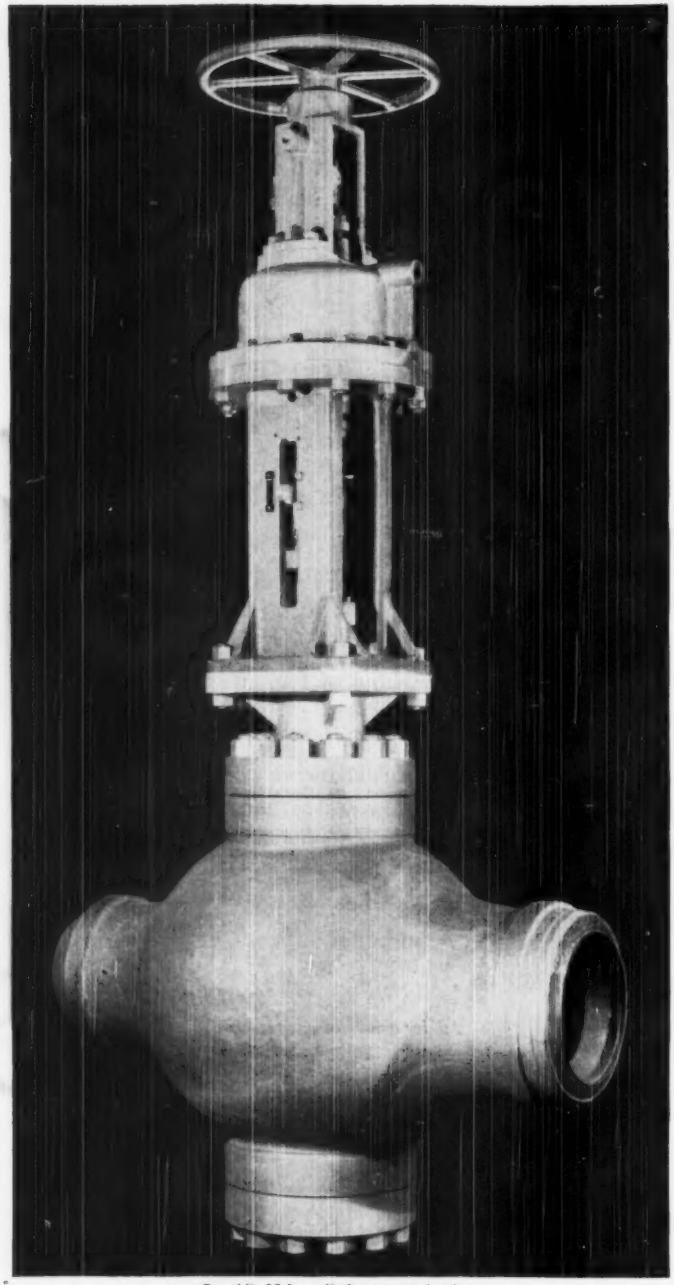
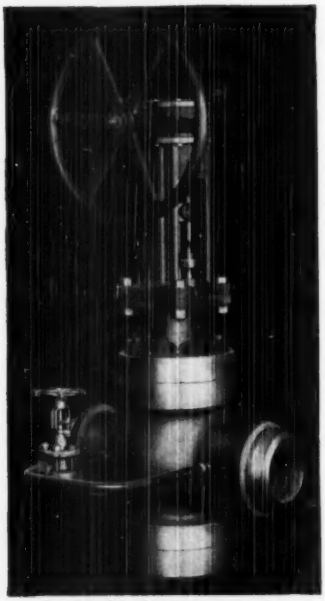


Republic 12 in. cylinder operated valve

REPUBLIC

GENERAL SPECIFICATIONS

- Built in all pressure standards—both flanged and welded ends.
- Streamlined flow through parts virtually eliminates erosion.
- Single seated valves—guaranteed drop tight.
- Double seated valves—guaranteed maximum leakage less than ½ %.
- Steam valves have heat treated stainless steel trim with screwed in seats.
- Water valves have welded in seat rings with hard surface overlay—on small valves overlay is made directly on body.
- All valves are engineered to the job or application.



Republic 6 in. hand operated valve

REPUBLIC FLOW METERS CO.

VALVES REPUBLIC

Regulating—Pressure Reducing—Shutoff

CYLINDER OPERATED—double seated

Republic cylinder operated valves are of the gradual opening, high lift, double seated type. They are hydraulicly operated to assure smooth performance at any speed regardless of size, stattic pressure or pressure reduction. These valves are available in sizes from 3" to 24", with or without hand operating wheel. Due to compact design, a regulator may be mounted directly on the valve.

HAND OPERATED—large sizes

Republic hand operated valves, in sizes from 3" to 8", are built to 900 lb. and 1500 lb. pressure standards. They are of the single seated type, have a one piece valve stem, and seat rings that are Stellite surfaced and welded in place. The gear reduction head is built with ball or roller bearings and precision ground gears for minimum friction and back lash. These valves are recommended for flow control and shutoff applications.

HAND OPERATED—small sizes

Republic single seated hand operated valves are also available in 1", 1½" and 2" sizes, built to 600 lb., 900 lb. and 1500 lb. pressure standards. These valves also have a one piece valve stem, and a Stellite surfaced seat integral with the valve body.

LEVER OPERATED—large sizes

Republic double seated lever operated valves are ideal for air actuation with long stroke cylinders. They are available in sizes from 3" to 16" for low pressure applications and in sizes up to 6" for 1500 lb. applications. The lever mechanism, of sturdy construction capable of taking full strains of power cylinders, is adjustable with full cylinder stroke to change valve capacity.

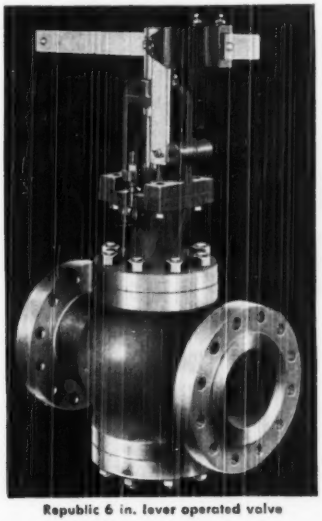
LEVER OPERATED—small sizes

Republic single seated lever operated valves are available in sizes up to 2" and for pressures up to 1500 lb. standard. The valve seat is Stellite surfaced and integral with the valve body. The sturdy lever mechanism is adjustable for lift. Many of these valves are in operation on water lines with over 1000 lbs. pressure reduction

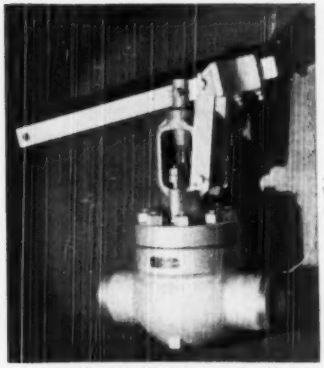
BUTTERFLY VALVES

Republic butterfly valves can be supplied in cast iron or steel for pressures up to 300 lbs. Vanes can be supplied of the angle seating or swing through types. The shaft can be mounted on ball or plain bearings as required. A valve operator may be mounted directly on valves of 6" size and over.

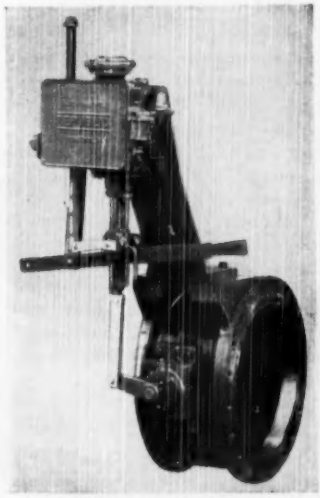
All Republic valves are engineered to the specific job on which they are to be used. Our engineers will be glad to consult with you on any of your valve problems. Write, asking to have one of our engineers call.



Republic 6 in. lever operated valve



Republic 2 in. lever operated valve



Butterfly valve with operator

2240 Diversey Pkwy., Chicago 47, Illinois

In Modernization, FLEXIBILITY COUNTS

GET POWER WITH

In plants where modernization programs frequently require shifting of equipment from place to place, drives with flexibility of application are a "must". This is one more reason why General Electric's STANDARD line of mechanical-drive turbines is winning such favor with progressive industries. The DP turbine can be easily transferred from one job to another, its speed and range changed easily, its horsepower rating adjusted economically.

DP TURBINES PROVIDE FLEXIBILITY *THREE* WAYS

1. EASY TO RE-LOCATE

Shaft height is the same on all G-E standard single-stage turbines. This means that moving turbines from one job to another doesn't require a "custom line-up job." Not only shaft height, but size of coupling fit and keyways are standard on every unit.

DP turbines are quickly aligned, too. Unless casing temperatures are high, DP's can be lined up cold with the assurance that shaft lift will be within allowable limits when the turbines are heated. Such easy alignment is possible only on a center-line supported unit.

2. EASY TO ADJUST SPEED

By adjusting a simple handwheel, the speed setting can be varied within a 30% range. Once adjusted, the DP's hydraulic governor holds speed accurately.

If a change in application makes a new speed range necessary, the range can be set anywhere from 800 to 5000 rpm by simply substituting a new emergency governor and a new set of low-cost gears on the governor drive. These gears are standard, available on immediate delivery from the factory.

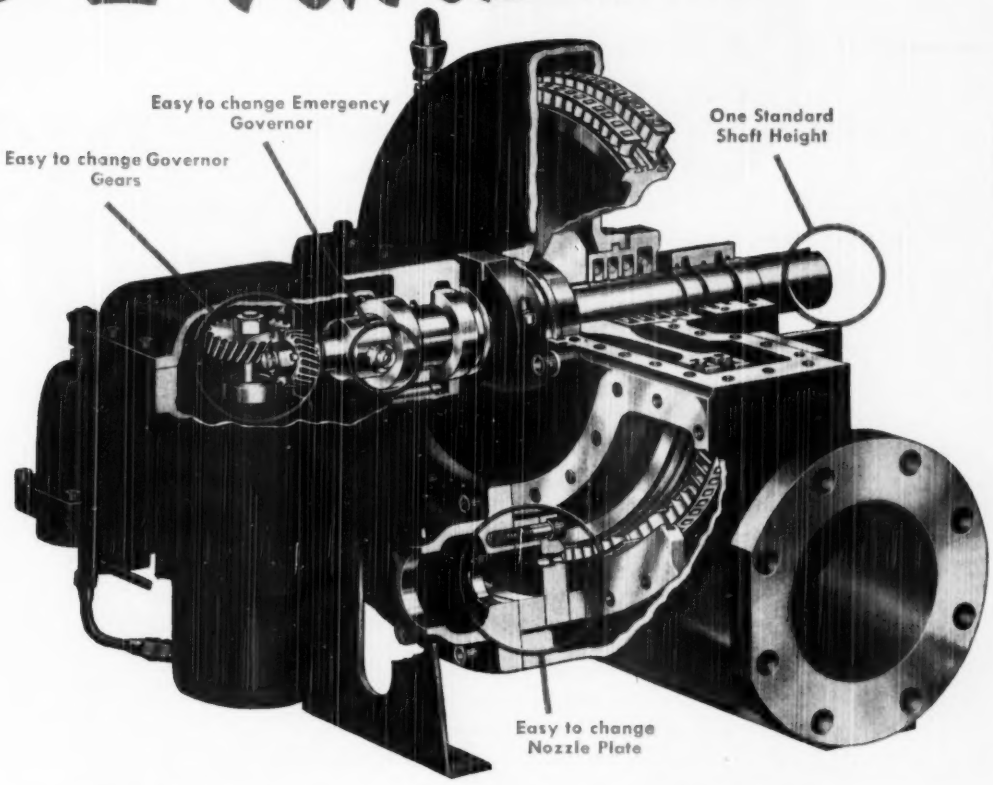
3. EASY TO CHANGE RATING

When steam conditions or load demands change, a DP turbine can be adapted at a reasonable cost for the new requirements if they are within the steam flow capacity of the casing. Example: If it is desired to increase the horsepower rating, the only changes which are usually necessary are new nozzle plate and valve parts. The cost of such parts is far less than the cost of a new turbine—which would be required with a less flexible unit.

REMEMBER...

"DP means Dependable Power"

FLEXIBILITY G-E TURBINES

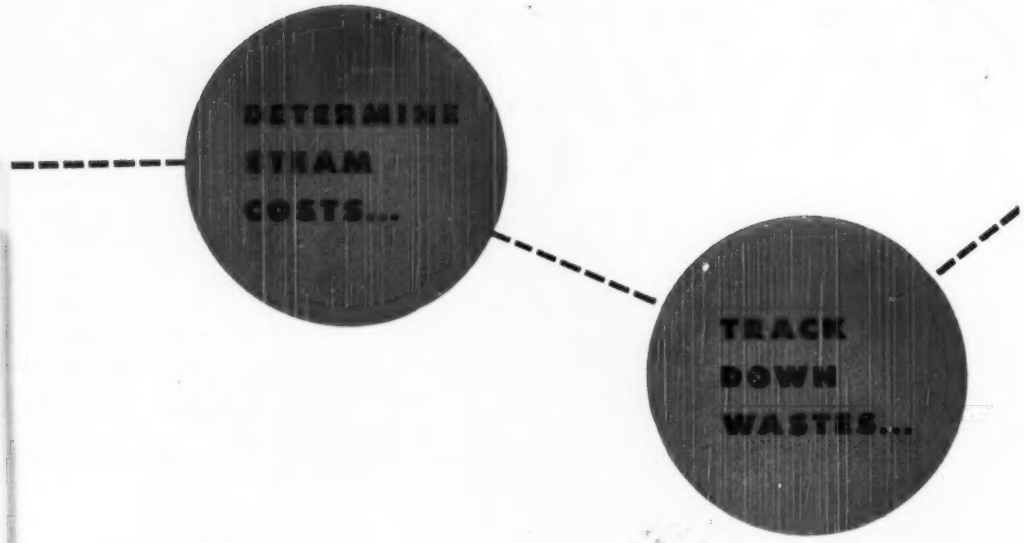


The General Electric standard DP Turbine incorporates many outstanding features previously found only on "special" turbines. They give you a drive which is dependable and flexible—ideal for a variety of applications in your plant.

For the full story on how these features can mean operating benefits for you, call your G-E representative. Or write today for GEA-4955, a 20-page, descriptive bulletin. Apparatus Dept., General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

252-43



Your costs for distribution and utilization of steam (or other fluid) will be known facts with the installation of a Brown Flow Accounting Meter. And you'll be able to put your finger on leaks and uneconomical operations . . . because the hourly and daily records will let you know, not approximate, what is happening, where it is happening, and when it is happening.

Brown Flow Accounting Systems are producing sensational economies in many plants, repaying the original investment in a very short time. *A Brown Recording Integrating Flow Meter . . . complete for a six inch line . . . costs less than $500.00!*

Check, today, on the application of such an accounting system for your processes. Call in your local Honeywell engineer for specific information . . . he is as near as your phone!

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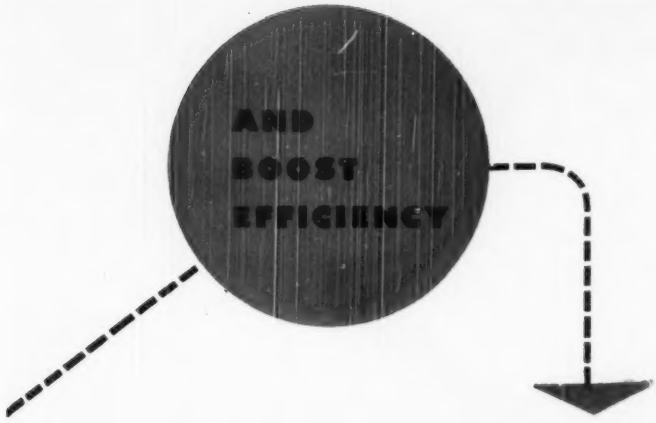
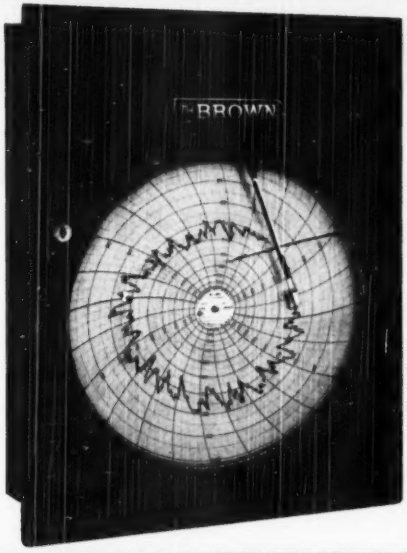
MINNEAPOLIS-HONEYWELL REGULATOR CO. • BROWN INSTRUMENTS DIVISION

4490 Wayne Ave., Philadelphia 44, Pa.

Offices in 73 principal cities of the United States, Canada and throughout the world

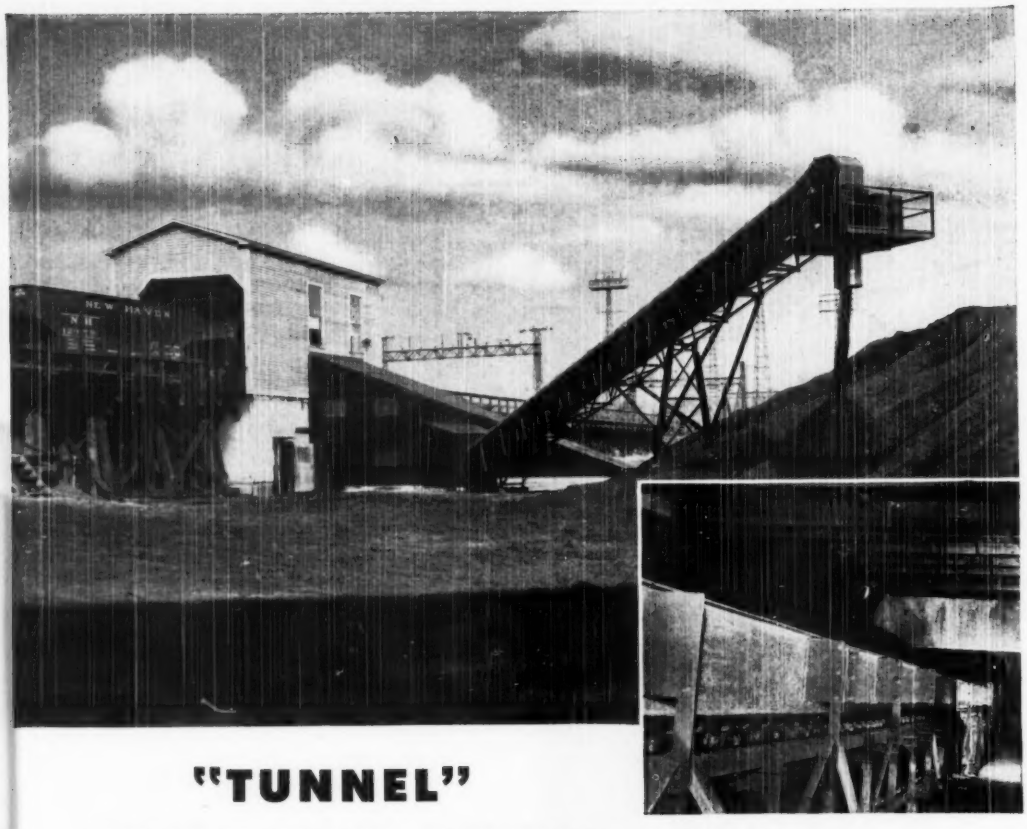


WITH THE BROWN ACCOUNTING FLOW METER



Bulletin 2022, "Brown Flow Meters for Cost Accounting," is complete and informative. A copy will be sent to you upon request. Write today!

Honeywell *Advanced Instrumentation* BROWN
FOR BETTER PROCESSING



"TUNNEL" FEEDS RAIL POWER HOUSE

Underground pan conveyors operating in a tunnel under the outdoor storage area are a feature of this S-A designed coal handling system. This fast, low cost system permits large storage and easy reclaiming with a minimum of manual effort.

Today, as for the past half a century, leading industries in practically every field, depend on S-A engineers for design and installation of highly efficient handling systems. Designed according to latest engineering principles, to do specific handling jobs, S-A systems for coal and ash handling provide maximum tonnage moved at lowest cost per ton.

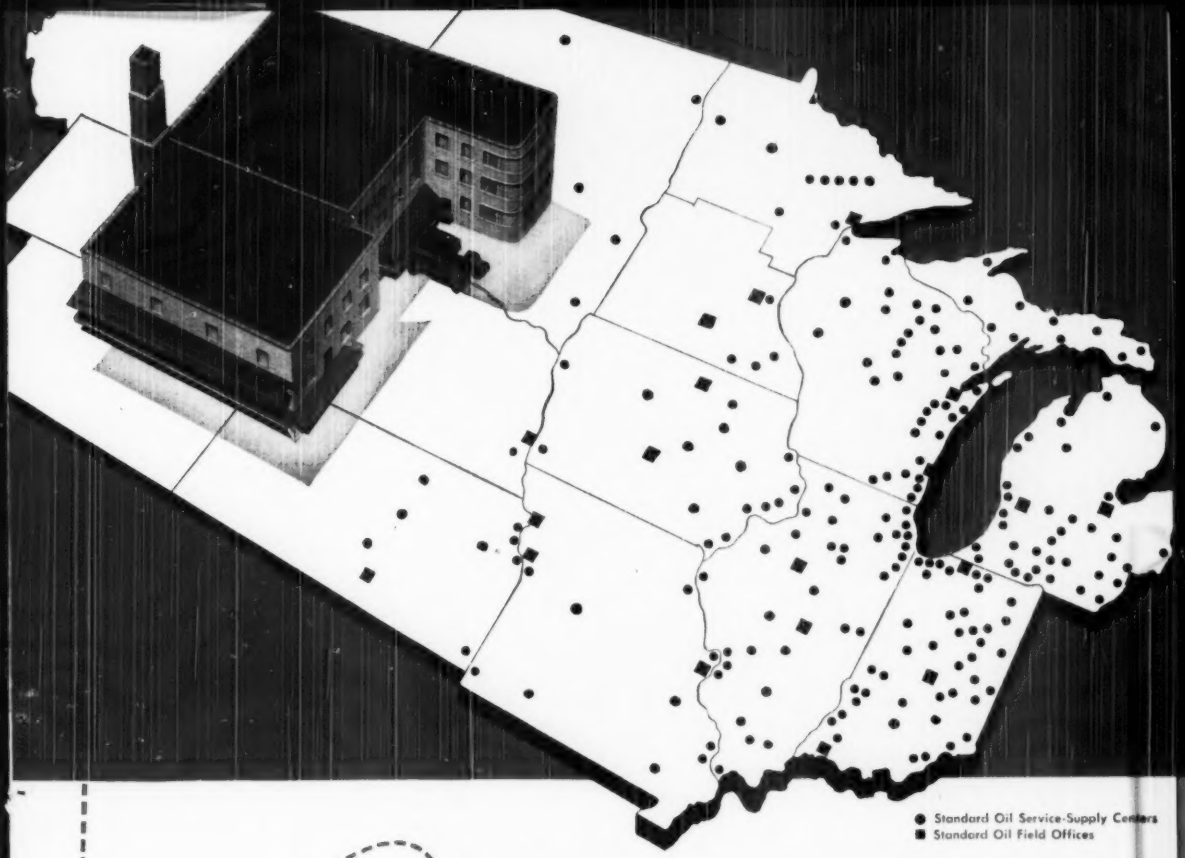
While you are in the planning stage of any improvement of your present system or design of a new system, ask first for the recommendations of S-A engineers. There's no obligation . . . write today.

Coal is dumped from hopper-bottom rail cars to receiving hopper for the first step of this S-A designed coal handling system. If boiler house bunkers are full, inclined belt conveyor takes coal to outdoor storage pile. Bulldozer spreads it over a wide area. When boiler house needs coal, bulldozer unit scoops coal into underground reclaiming hopper. S-A inclined pan conveyor, operating in tunnel under coal storage area, returns coal for transport to bunkers.

STEPHEN S-A DAMSON MFG. CO.

5 Ridgeway Avenue, Aurora, Illinois — Los Angeles, Calif. • Belleville, Ontario

DESIGNERS AND MANUFACTURERS OF ALL TYPES OF BULK MATERIALS HANDLING EQUIPMENT



Right in your own back yard!

● If your plant is in the Midwest, you can benefit from a service-distribution set-up that is unique in the oil industry – there's a Standard Oil office and warehouse practically right in your own back yard. The nearness of that service-supply center holds important advantages for you.

Faster Deliveries. You needn't worry about production delays caused by late shipments of necessary lubricants and fuels. You can avoid the expense and trouble of stocking large quantities of lubricants and fuels within your plant.

A Complete Supply. Every lubricant and fuel necessary to the efficient operation of your plant will be carried in the warehouse at your nearby Standard Oil service-supply center. You can always get the product you need *when* you need it.

On-the-Spot Engineering Service. Your nearby Standard Oil service-supply center is headquarters for a Standard Oil Lubrication Specialist who is assigned to your plant. He is close at hand to give you help when you need it. He has plenty of practical experience. He has been specially trained for his job in a Standard Oil Lubrication Engineering School. He is backed by Standard Oil's extensive research and technical facilities.

To arrange for his visit, phone your nearby Standard Oil service-supply center or write to: Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

3 IMPORTANT ADVANTAGES

Standard Oil's Lubrication Service is especially geared to serve your midwest operations.

1 Service-supply points are near your plant. You are assured of fast deliveries, prompt lubrication engineering service.

2 Lubrication specialists have been specifically trained in Standard Oil Lubrication Engineering Schools to help you obtain the maximum benefits from lubricants and fuels.

3 Research and technical facilities are geared to help solve your specific lubrication problems.

STANDARD OIL COMPANY (INDIANA) STANDARD

What's YOUR problem?

R. L. Jenkins, lubricating specialist at Standard Oil's South Bend office solved this customer's problem because he was thoroughly familiar with job requirements and the application of his Stanorust line.

There is a corps of such lubricating specialists throughout the Midwest, trained and experienced to help plant operators solve similar problems. Experience enables these men to find quickly the cause of lubricating troubles. Knowledge of petroleum products enables them to prescribe the lubricant needed. There is one of these lubricating specialists at the Standard Oil Company (Indiana) office near you. He is there to serve you. A call or a card will put him at your service.

Investigate the cost-saving possibilities of these lubricants.

STANOIL INDUSTRIAL OILS—for cleaner hydraulic systems, gear cases, compressors, and circulating systems.

CALUMET VISCOUS LUBRICANTS—adhere to open gears and chain drives without throw-off. Easy to apply. No heating.

STANOLITH GREASE—withstands high temperatures and resists washing by water.

THE SHOP FOREMAN of Hart Pressed Steel Corp., Elkhart, Indiana, exposes the clean metal surface beneath a coating of STANORUST 1-XC Rust Preventive by a simple wiping operation. The die shown has been protected against rust under severe outdoor conditions for over a year by STANORUST 1-XC.

How to prevent rust under severe outdoor storage . . .

RAIN, snow, heat, cold—plus coal soot from passing locomotives—could be expected to produce serious rust troubles in outside storage. The elements did, indeed, cause difficulties for the Hart Pressed Steel Corp., Elkhart, Indiana, which owns the truck and trailer dies shown above. Despite coatings of heavy oil, rusting was so severe that cleaning a die required at least three hours.

The problem was laid before a Standard Oil lubrication specialist. He pointed out that, to withstand severe outdoor exposure, a rust preventive with special qualities is needed. At his suggestion, the dies were coated with STANORUST 1-XC, a rust preventive especially developed for severe outdoor service.

Use of a STANORUST Rust Preventive has made savings for this company. Many of the dies have been exposed to the weather for over a year, yet STANORUST has kept them completely protected against rust. A die can now be cleaned and returned to service in a matter of ten minutes, as compared with the three hours previously required.

The new and improved STANORUSTS can mean big savings for you through more economical applications, better rust protection. There's a lubrication specialist near you who can help you get the most economical results. How you can obtain his services is described at left. Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANORUST
REG. U. S. PAT. OFF.
RUST PREVENTIVES

STANDARD OIL COMPANY (INDIANA) STANDARD

For Heavy Duty Steam Generating Plants

Springfield's

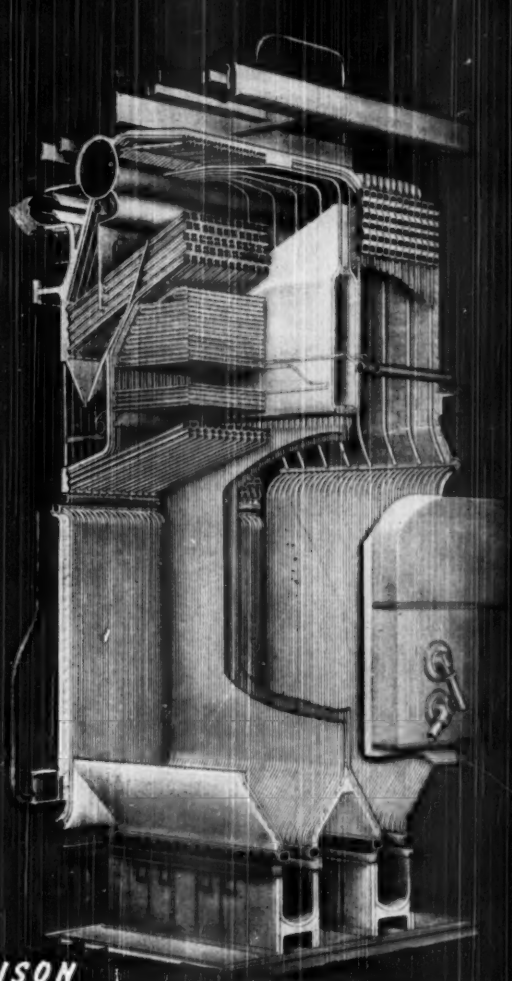
DIVIDED FURNACE WITH CENTER WATER WALL

THE divided furnace with a CENTER WATER WALL* is a development first introduced by Springfield Boiler Co., for large central station installations. It has application where gas temperatures entering the first pass and superheater must be limited to prevent overheating of the center section of the wider furnaces. It enables a unit to stay on the line longer before shutting down for maintenance and cleaning.

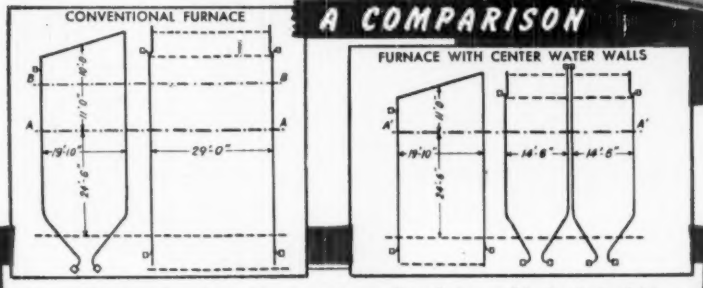
The divided furnace construction has been highly dependable and successful in service. It is adaptable to any kind of firing. Springfield offers it on both bent tube and straight tube boiler designs.

*Patented

CHECK WITH YOUR CONSULTING ENGINEER ON YOUR MODERNIZATION AND NEW PLANT PROJECTS



A COMPARISON



These diagrams show how the *center water wall* made it possible for Springfield to reduce the height of furnace 22% on one 350,000 lb. pulverized coal fired unit in addition to securing a more even gas temperature entering the first pass across the width of the unit.

SPRINGFIELD PRODUCTS

BENT TUBE STEAM GENERATORS—Modern designs for capacities from 10,000 lbs. up.

STRAIGHT TUBE BOILERS—Specially designed for capacities from 5,000 to 450,000 lbs. per hour and higher.

STANDARDIZED TYPE M BOILERS—Standardized for quicker delivery and lower cost. Sizes 6,000 to 17,000 lbs. per hour.

WATER COOLED FURNACES—Heavy duty water walls. Exclusive center water wall construction for larger units.

SUPERHEATERS — AIR HEATERS — ECONOMIZERS—Individually designed to meet requirements.

SPRINGFIELD BOILER CO.

1953 E. CAPITOL AVENUE SPRINGFIELD, ILLINOIS

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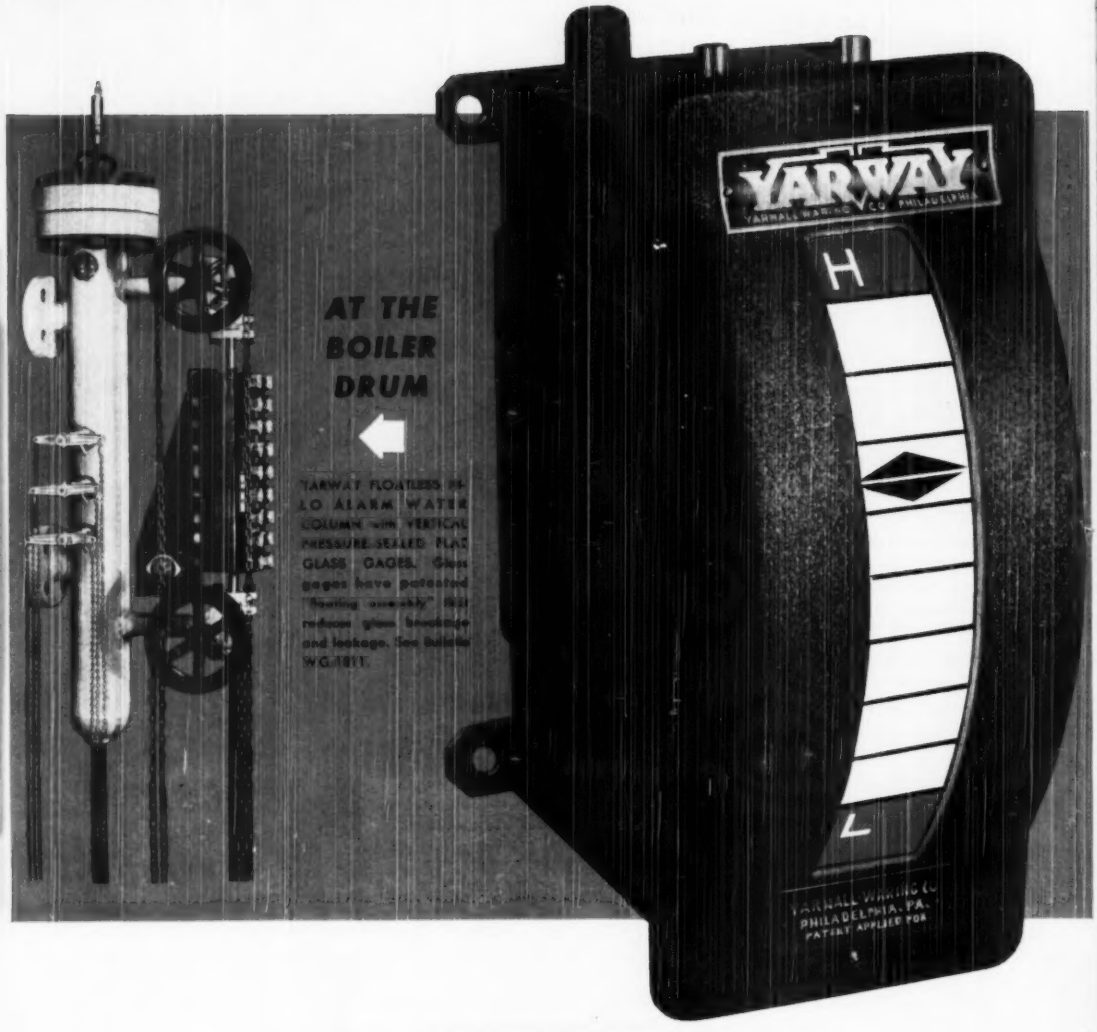
SPRINGFIELD BOILERS

See our catalog in SWEET'S

Boiler Water Indication



YARWAY

ON THE LEVEL with a Yarway System

It's accurate! It's where you can see it!

These two most important needs for boiler water level indication are assured with a Yarway system.

Yarway indicating equipment is accurate because it is *operated directly by the boiler water itself.* Yarway Weight-operated Hi-Lo Alarm Water Columns with either Sesure Inclined or Flat Glass Vertical Gages take care of the job at the boiler drum. On the instrument panel or other desired location, Yarway Remote Liquid Level Indicators bring overhead gage readings down to convenient, easy eye-level vision. By use of a Control Unit on the indicator, additional Hi-Lo light or sound alarms can be located at any place in the plant.

The Yarway HI-LO-GRAPH, a panel-mounted *recording* indicator, gives a 24-hour record of boiler water levels.

Yarway engineers will gladly show you how the Yarway Boiler Water Indicating System increases power plant *safety* and *efficiency.*

For the full story on Yarway Indicators, write for a free copy of Yarway Bulletin WG-1822

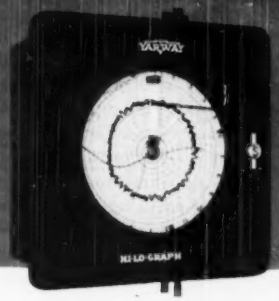
YARNALL-WARING COMPANY, 100 Mermaid Avenue, Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES

ON THE INSTRUMENT PANEL

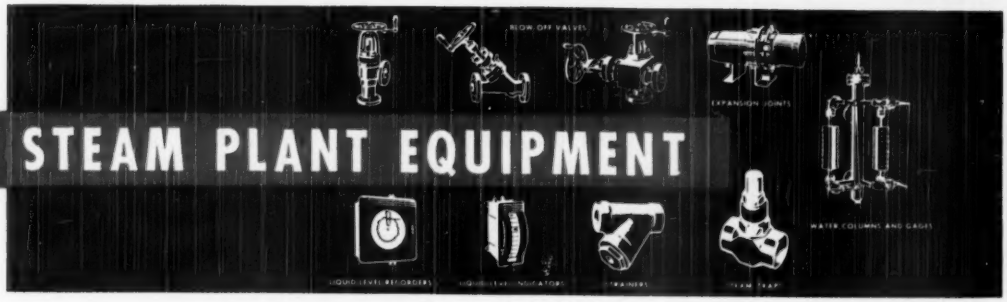
YARWAY REMOTE LIQUID LEVEL INDICATOR, operated directly by the boiler water itself, by the pressure differential between a constant head and the varying head in the boiler drum. Indicating mechanism is never under pressure—no sealing bosses. See Bulletin WG-1822.

YARWAY HI-LO-GRAPH RECORDER provides not only instant indication but also 24-hour recording of boiler water levels. See Bulletin WG-1830.

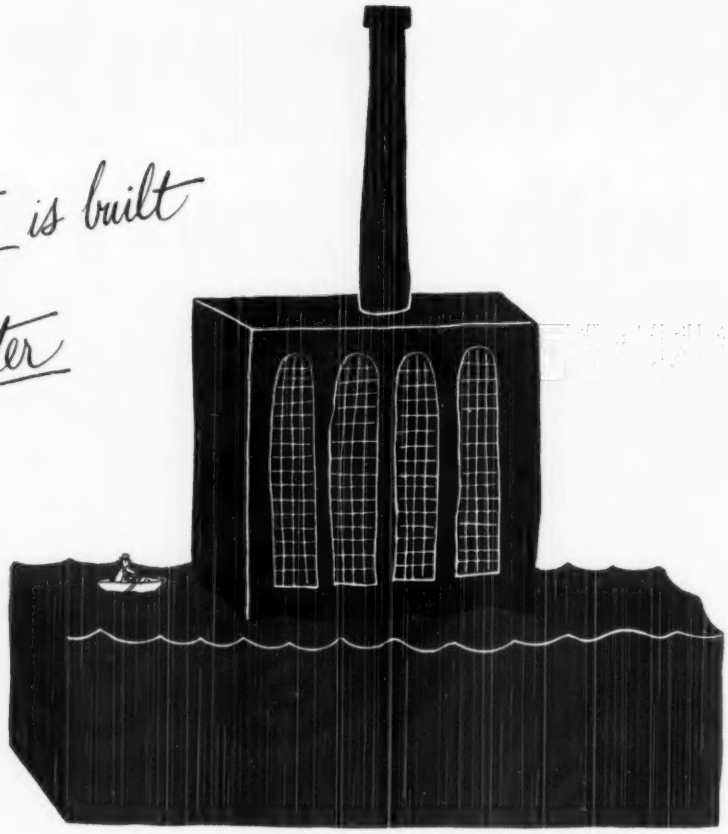


ANYWHERE IN THE PLANT

YARWAY REMOTE HI-LO ALARM SIGNALS, lights or horns. Operated by Control Unit attached to Remote Liquid Level Indicator or Recorder. Any number can be installed, at any desired locations throughout the plant. See Bulletin WG-1822.



Industry is built on water



WHETHER water is used only for steam generation or is required in plant process, it is today a major industrial problem. The nature and extent of available water supplies may be a primary factor in determining the location of a new plant, or in the continued efficiency of an existing plant.

Hall engineers have solved water supply problems for hundreds of industrial plants of all types and sizes.

Sometimes the solution has been relatively simple, such as the restoration of well capacity by means of a new well cleaning method developed by Hall associates. More often, however, the problem has been a complex one involving study of the characteristics of all available waters and of the quality, quantity and temperature requirements at all water usage points.

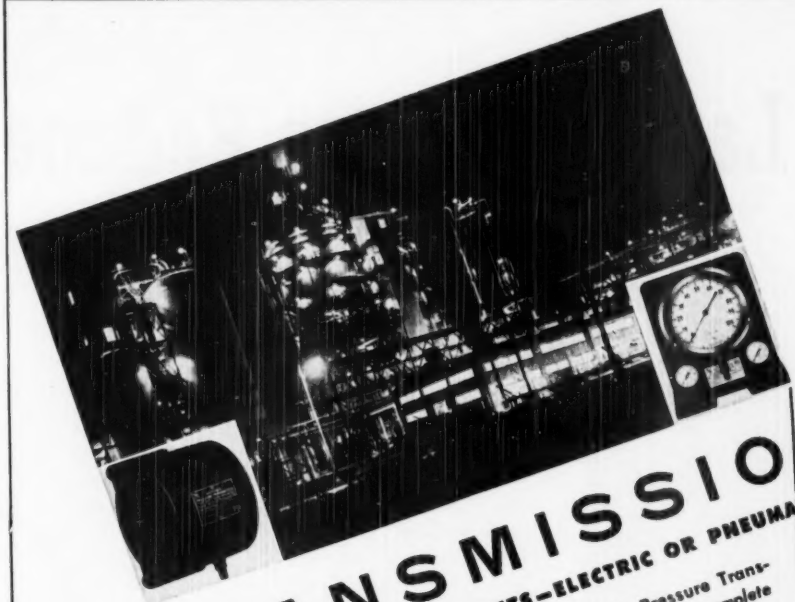
In every case, Hall recommendations are technically sound, practical, specific and economical, showing where and how each water can be used to best advantage with minimal treatment.

Whatever your water problem may be, you will be interested in the Hall bulletin, "Water Problems neither begin nor end at the boiler." May we send you a copy?

Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

HALL *plant-wide* WATER SERVICE

INDUSTRIAL WATER TREATMENT...BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL



TRANSMISSION

OF PRESSURE MEASUREMENTS—ELECTRIC OR PNEUMATIC

Ashcroft Pneumatic or Microsen Electric Pressure Transmission Systems bring to one operator a quick and complete picture of all the important process variables employed.

Safe, accurate, and economical, they are designed for pressures up to 50,000 p.s.i. *with no distance limitations.* Pressure elements incorporate all the design advantages of the famous Ashcroft Duragauge. There is an extensive selection of Bourdon tube designs, materials and protective devices for all conditions of service.

The Microsen Electric Transmitter employs the unique Microsen Balance principle. It delivers a straight line D.C. output signal free from drift and alternating current interference.

Both systems are easy to install, simple to maintain. Bulletins describing each system available upon request.

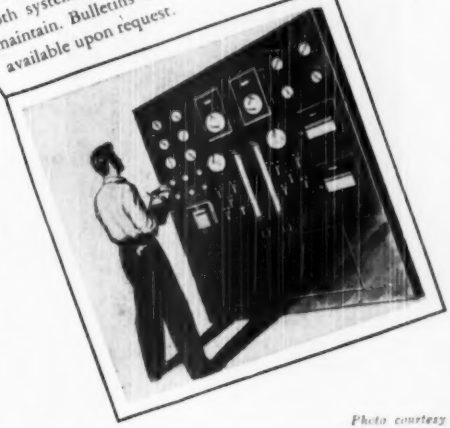


Photo courtesy Shell Oil

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MANNING, MAXWELL & MOORE

INCORPORATED

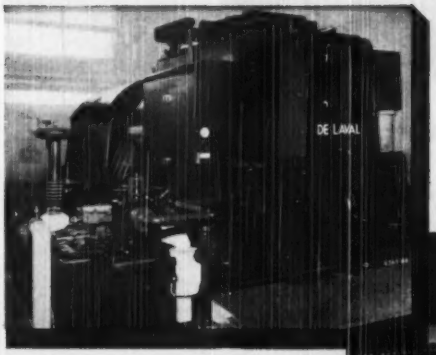
STRATFORD, CONNECTICUT

Makers of 'Microsen' Electrical and 'American' Industrial Instruments, 'Hancock' Valves, 'Ashcroft' Gauges, 'Consolidated' Safety and Relief Valves, Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists and other lifting specialties.

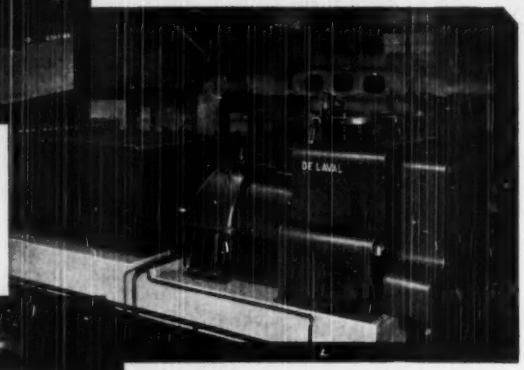
De Laval Turbines Reduce the Cost of Power

We clipped this article from a recent power journal because it does such an excellent job of emphasizing the savings that can often be effected by installing high pressure boilers and modern turbine generators.

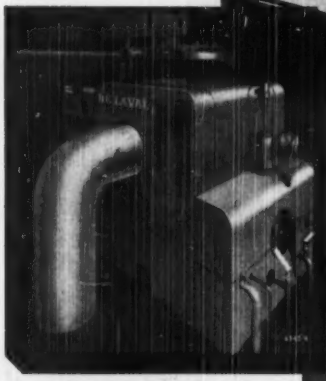
Why not check into your own power and steam costs? Recent installations like the ones shown below have proven that savings can be substantial. For more complete information write for Bulletin 4200.



▲ De Laval 5000 KW condensing turbo-generator receiving steam at 550 psig, with extraction at 90 psig.

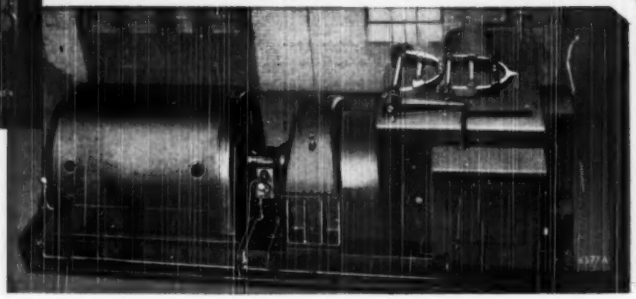


▲ 3500 KW De Laval turbine generator serving a large Mid-Western metal working plant.

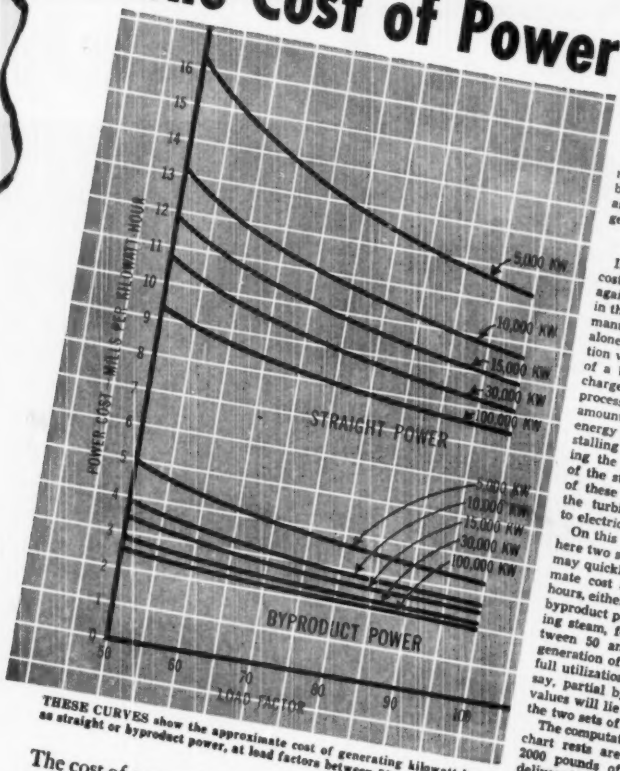


▲ De Laval 3000 KW non-condensing topping turbine installed in a chemical plant.

▼ 5000 KW De Laval turbine generator with automatic extraction.



The Cost of Power



THESE CURVES show the approximate cost of generating kilowatt-hours, as straight or byproduct power, at load factors between 50 and 100 per cent

The cost of generating electrical energy locally may be high or low. It depends on a number of factors, particularly the extent of the demand for process steam

DAVID MOFFAT MYERS • MYERS, FULLER & ADDINGTON
CONSULTING ENGINEERS, NEW YORK

How much does it cost to make a kilowatt-hour with a steam plant? The answer depends upon where it is to be made, how much electrical energy is to be generated in a year, and at what load factor; what fuels will be availabe and their cost per million B.t.u.; the quality of the water supply; the kind of labor available and rate of pay. Last, and most important of all, it depends on the amount of steam that may be required for heating or process along with the kilowatt-hours.

If no steam is needed for process or heating purposes, we have a straight power job. On the other hand, with a relatively large requirement for steam as well as power, we may have 100 per cent byproduct power generation.

The straight power will cost the most per kilowatt-hour and the byproduct power the least. These are the two extremes of cost in the generation of electrical energy.

Cost of Byproduct Power

In straight power generation all costs of necessity are chargeable against the energy so produced. But in the case of byproduct power, the manufacturing and heating steam alone, without any power generation whatever, requires installation of a boiler plant of full capacity, chargeable entirely to heating and process steam. For this same amount of steam the byproduct energy becomes available by installing topping turbines and raising the pressure and temperature of the steam. Only the extra cost of these items and attendance of the turbine room are chargeable to electrical energy.

On this basis there are presented here two sets of curves from which may quickly be found the approximate cost of generating kilowatt-hours, either as straight power or as byproduct power from manufacturing steam, for any load factor between 50 and 100 per cent. For generation of power with less than full utilization of steam—that is to say, partial byproduct power—the values will lie somewhere between the two sets of curves.

The computations upon which the chart rests are based on $10 for 2000 pounds of 13,000 B.t.u. coal delivered in the overhead bunker. Prevailing prices and costs have been used for labor and the purchase and installation of power plant equipment, including land, buildings, and all auxiliaries.

While any individual case will be governed by the design of the plant and the specific conditions and factors involved, the chart serves as a fair indication of the spread between the cost of straight power and byproduct power generation.

The upper curves apply equally well to central stations of public utilities of the capacities indicated, the cost per kilowatt-hour being taken at the outgoing bus. Before the consumer gets the juice there must be added, of course, the necessary charges to cover transmission, distribution, and service.

DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

DE LAVAL

T-27

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"Sweet's simplifies fact-gathering—makes it easy to compare various manufacturers' products."

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"The supplier who files his catalog in Sweet's speeds up my buying."

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DIVISION OF F. W. DODGE CORPORATION • 119 WEST 40TH STREET • NEW YORK 18, N. Y.

Gruelling tests... An essential part of every

Fig. 2150
150 lb. S.P.
Bronze Gate

RIGID TESTING, far above the usual practice, is regular procedure in the production of Lunkenheimer Valves. From selection of raw materials to final assembly, nothing is left to chance or guess. Each and every operation is gauged to meet the high quality standards which assure dependable performance, longer service life and minimum upkeep.

In gate valves, for example, a Lunkenheimer final test means that every valve is tested on both sides, at high and low pressure for seat tightness and then given a careful shell test. Spot testing is not tolerated.

This may be producing valves the "hard way", but for Lunkenheimer, it's the only way since it safeguards our proudest possession . . . the mark of unswerving quality and dependability.

ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI 14, OHIO, U.S.A.
NEW YORK 13 · CHICAGO 6 · BOSTON 10 · PHILADELPHIA 34
EXPORT DEPT. CINCINNATI 14, OHIO, U.S.A.

Continually improved testing equipment, together with superior metallurgy and the most modern production equipment assures longer and trouble-free operation, making Lunkenheimer Valves cost less per year of service.

Leadership through Achievement!

LUNKENHEIMER VALVE

...and the final step and proof of Quality in these 150 lb. S. P. Bronze Gate Valves.

The valves illustrated, Figs. 2150, 2151 and 2153, typify the extra value Lunkenheimer puts into its product. Here are three designs, each for a specific purpose, so carefully engineered and produced, that any one type can be converted to another by a simple interchange of trimmings, with full assurance of a perfect fit. Where both rising and non-rising stem valves are used, this feature means lower stock room investment, fewer parts required, and reduced maintenance expense.

In addition to this flexible interchangeability of parts, superior design, and exceptionally rugged construction, these valves have the distinctive silicon bronze alloy stem material developed by Lunkenheimer. Stem-thread failure due to wear is eliminated.

Ask your Lunkenheimer Distributor, or write direct for Circular Number 574, which fully explains the interchangeability and other features of these valves.

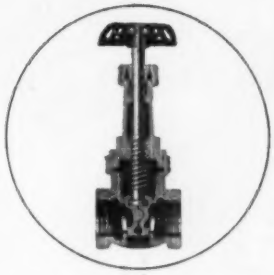


Fig. 2150—Double Wedge Disc, Rising Stem Ball and socket construction. No internal wedge or pin to wear or be lost. Discs readily adjust themselves to taper seats, insuring a tight valve. Sturdy disc collar strengthens disc-stem connection.

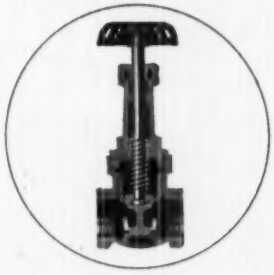


Fig. 2151—Solid Wedge Disc. The solid disc is ideal for services such as food processing lines and handling gummy substances, where entrapment of line materials within the disc is undesirable.

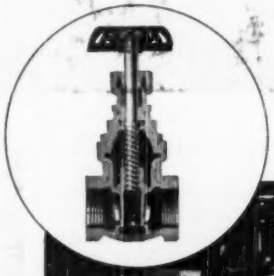


Fig. 2153—Embodies all the features of Figs. 2150 and 2151, but its design is varied to provide non-rising stem operation. Body is the same, requiring only an interchange of trimmings to convert from non-rising stem to rising stem.

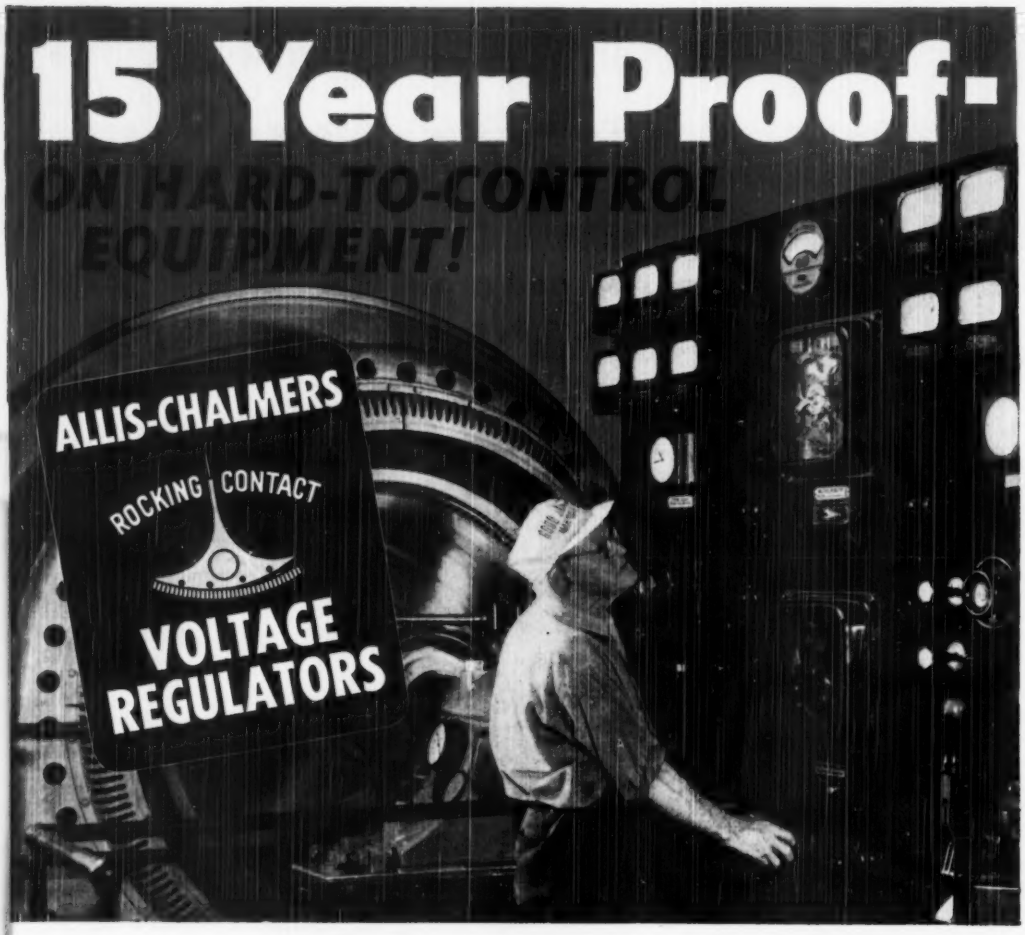
Another assurance of better valve service

is your on-the-spot Lunkenheimer distributor, ready with stocks and facilities to serve as your warehouse, keep your production going, save you dollars and hours. Whether it's an emergency, routine maintenance or new installation, call your Lunkenheimer Distributor for fast, dependable service.

Battery of Semi-Automatic Gate Valve Seating Machines

15 Year Proof-

ON HARD-TO-CONTROL EQUIPMENT!



REGULATING VOLTAGE for the Good Samaritan Hospital of Cincinnati since 1934 without maintenance or repair of any sort except for one bearing adjustment . . . that's the record of these Allis-Chalmers Rocking Contact Voltage Regulators. "Our machinery is slow speed—difficult to control—yet our regulation is good!" says Mr. W. A. Garrett, Chief Engineer.

This is the kind of *proven* dependability and low maintenance you can get with Rocking Contact Regulators. They have no vibrating contacts and no gliding friction . . . no complex adjustments to make. This simplicity means years of trouble-free service for you.

They are precision built for *Instant Response* and *Accuracy*. Contact sectors are supported in jeweled bearings . . . rock on carefully machined commutator segments heavily plated with silver for reliable, long-life accuracy.

Rocking Contact Voltage Regulators are available for both a-c and d-c generators of any size and speed, for either parallel operation or unit control. Call your nearby A-C office or write direct. A-2887

ALLIS-CHALMERS, 952A SO. 70 ST.
MILWAUKEE, WIS.

OTHER ALLIS-CHALMERS SPECIAL CONTROL

SYNCHRO-OPERATOR — Automatically synchronizes alternating current generators, tie lines, synchronous condensers, etc.

D.C. POSITIONER — Operates from power plant d-c bus, used for remote indication, control, order telegraph, etc.

REGULEX CONTROL — Used where the features of a rotating type regulator are desired.

Regulex is an Allis-Chalmers trademark.

ALLIS-CHALMERS

Pioneers in Power and Electrical Equipment from Generation through Utilization

Yes, it's Youngstown!

Dependable Steel Pipe . . . Adequate Tomorrow, as Today

INSTALL Youngstown today, in sizes adequate for the increased loads it will have to carry tomorrow, and both you and your customers can forget pipe indefinitely.

The dependability of Youngstown Steel Pipe rests on experience--on nearly 50 years of producing highest quality steel and fabricating it into highest quality pipe.

Youngstown Steel Pipe is available every where, sold by leading pipe distributors who are prepared to recommend and furnish it in proper sizes for any job, adequate for both tomorrow's needs and today's.

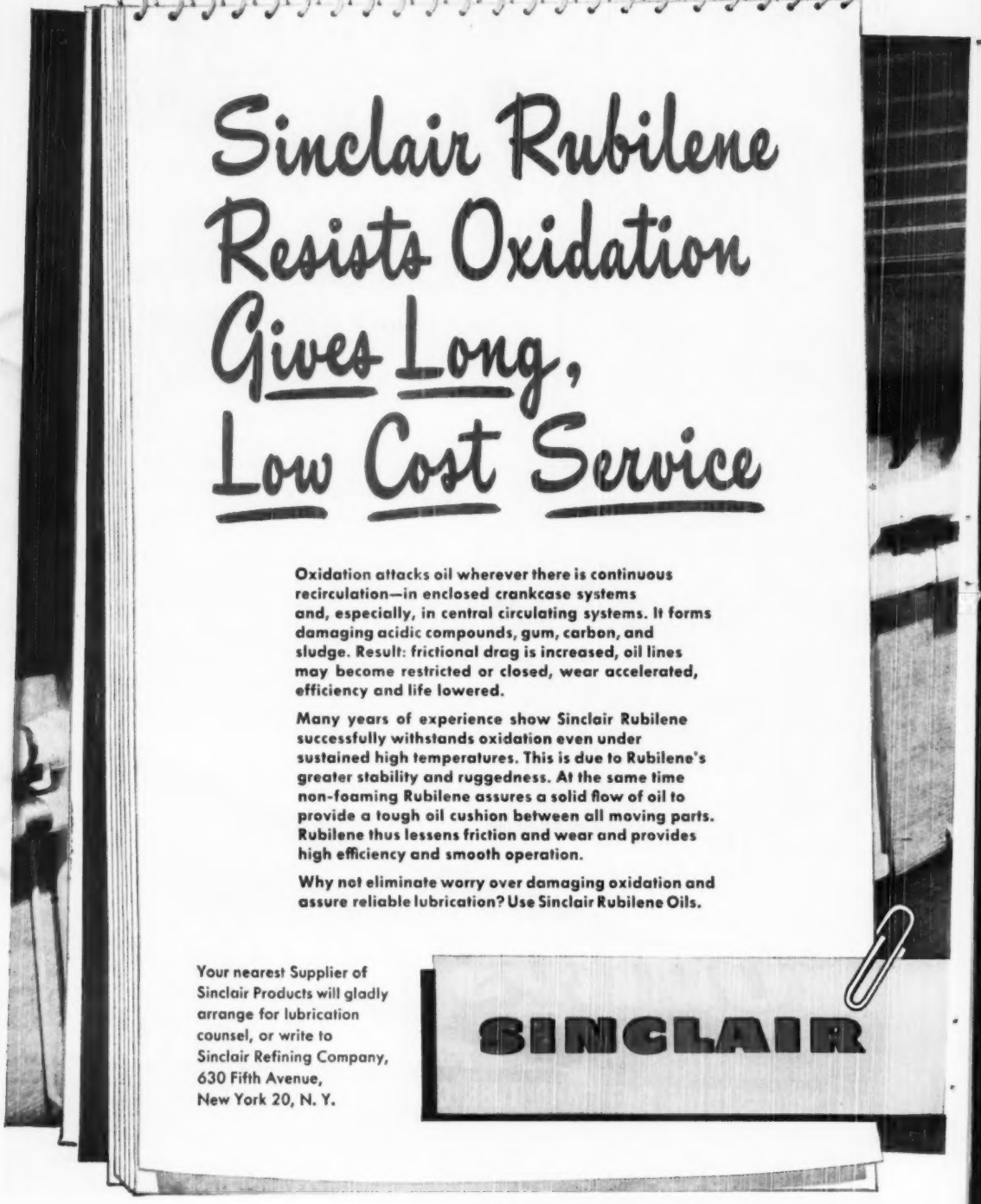
Youngstown STEEL PIPE

THE YOUNGSTOWN SHEET AND TUBE COMPANY — General Offices — Youngstown 1, Ohio

Manufacturers of Carbon, Alloy and Yoloy Steel — Export Office - 500 Fifth Avenue, New York

PIPE AND TUBULAR PRODUCTS · CONDUIT · BARS · RODS · COLD FINISHED CARBON AND ALLOY BARS · SHEETS · PLATES · WIRE · ELECTROLYTIC TIN PLATE · COKE TIN PLATE · RAILROAD TRACK SPIKES.

Sinclair Rubilene Resists Oxidation Gives Long, Low Cost Service



Oxidation attacks oil wherever there is continuous recirculation—in enclosed crankcase systems and, especially, in central circulating systems. It forms damaging acidic compounds, gum, carbon, and sludge. Result: frictional drag is increased, oil lines may become restricted or closed, wear accelerated, efficiency and life lowered.

Many years of experience show Sinclair Rubilene successfully withstands oxidation even under sustained high temperatures. This is due to Rubilene's greater stability and ruggedness. At the same time non-foaming Rubilene assures a solid flow of oil to provide a tough oil cushion between all moving parts. Rubilene thus lessens friction and wear and provides high efficiency and smooth operation.

Why not eliminate worry over damaging oxidation and assure reliable lubrication? Use Sinclair Rubilene Oils.

Your nearest Supplier of Sinclair Products will gladly arrange for lubrication counsel, or write to Sinclair Refining Company, 630 Fifth Avenue, New York 20, N. Y.

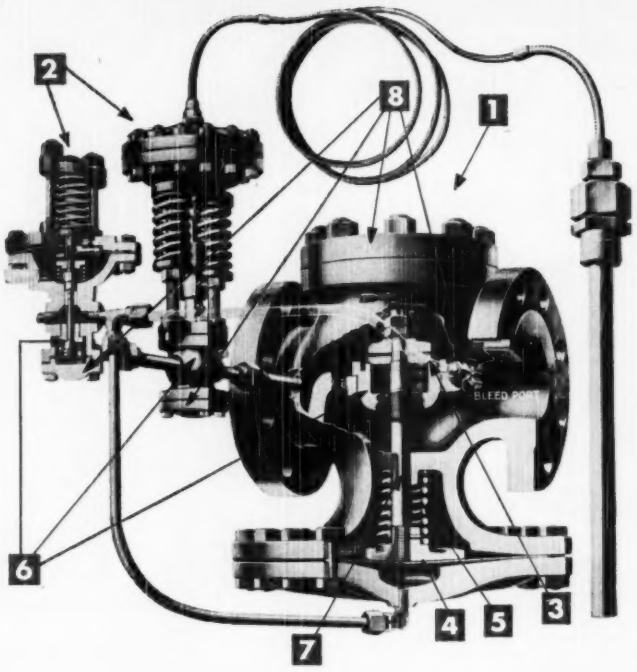
SINCLAIR

Sustained New-Oil Quality
Long Oil Life
Tough Oil— Less Wear
Circulates Freely
ELLIOTT
INDUSTRIAL OILS

NOW! CUT COSTS OF PRESSURE

These SPENCE features *show you how:*

YOU SAVE MONEY with Spence Self-Operated Regulators because they function dependably and accurately year after year *without requiring extensive repairs or special attention.* This long trouble-free life means less down-time of the system, less time and money wasted on replacement of parts. Thus, you lower over-all costs and, at the same time, are assured of quality performance.



The cutaway illustration above shows why Spence Regulators . . .

REGULATE ACCURATELY

1 The single-seated *packless* main valve is actuated by a large balanced diaphragm. The construction eliminates the need for closely fitted parts which may stick or bind due to uneven expansion or foreign matter.

2 One or more sensitive pressure or temperature pilots control the main valve.

Because the Spence design minimizes friction, accurate regulation remains unaffected by changes in service conditions or length of service.

STAY ON THE JOB FOR YEARS

3 SECO Metal Seats and Discs resist wiredrawing. More than 20 years of experience with SECO Metal in thousands of installations has failed to produce one single case where SECO Metal has been cut by steam.

4 Spence metal diaphragms, under usual conditions, never require replacement. Spence Regulators have few moving parts and those few are ruggedly constructed and seldom require attention.

5 The spring in the Spence Regulator is out of the path of the fluid flowing through the valve. It operates at low unit stress to assure performance over an unusually long life.

REDUCE MAINTENANCE

6 The seat and disc of the main valve and pilot can be cleaned and any working part removed, without taking the main valve out of the line.

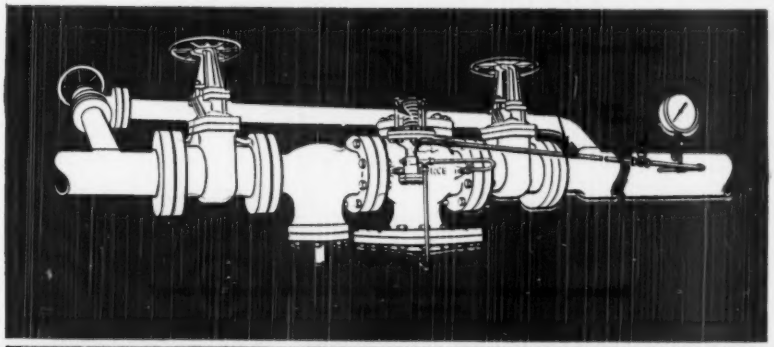
7 All main valves and most pilots are built without stuffing boxes. This packless construction eliminates much time-consuming maintenance.

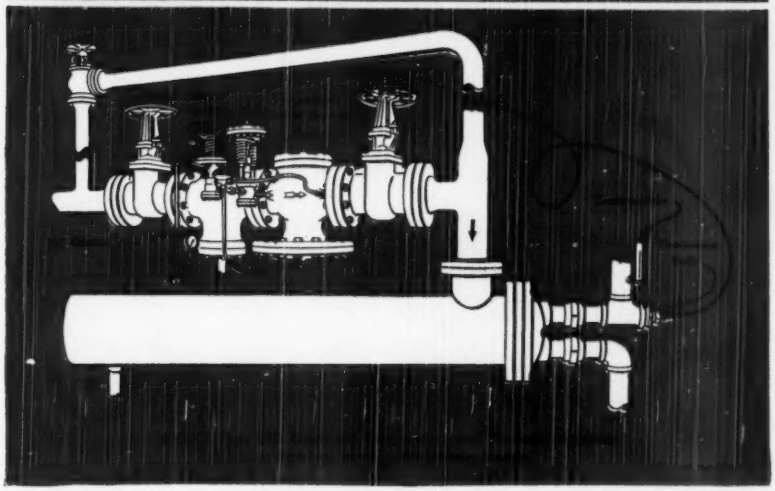
8 No dismantling is necessary to inspect the main valve disc, the pilot valve member and the SECO Metal bleedport. Special openings are provided. Inspection is easier, too, because the pilot is not an integral part of the main valve.

SPENCE ENGINEERING COMPANY, INC.

AND TEMPERATURE CONTROL

TYPICAL INSTALLATIONS





PARTIAL LIST OF USERS

- The Cleveland-Cliffs Iron Company
- Tennessee Coal, Iron and Railroad Company
- The Springs Cotton Mills
- Ford Motor Company
- Cochrane Corporation
- Philadelphia Electric Company
- Pennsylvania Power & Light Company
- L. H. Gilmer Company Div. of United States Rubber Co.
- York Corporation
- Jones & Laughlin Steel Corporation
- The Duluth Steam Corporation
- Rochester Gas and Electric Corporation
- Consolidated Gas Electric Light and Power Company of Baltimore
- Phenix Natural Gas Company
- Cutter Laboratories
- National Tube Company
- The Atlantic Refining Company
- Great Lakes Steel Corporation
- Union Electric Company of Missouri
- Todd Shipyards Corporation
- Oxford Miami Paper Company
- Land O'Lakes Creameries, Inc.
- Ohio Edison Company
- General Electric Company
- R. J. Reynolds Tobacco Company

HAVE UNUSUAL VERSATILITY

9 The Spence Regulator, due to its unique design, will serve many functions and will handle all the various types of fluids under a wide range of service conditions. One of the great advantages of this Spence design is the interchangeability of all pilots on all sizes of main valves. Any main valve can be changed from a pressure to a temperature regulator or vice versa *simply by substituting one type of pilot for another.*

Spence Regulators are built in sizes from 1/4" to 12" for service with air, steam, water, oil or gas. With minor adjustments, any Spence Regulator can be easily switched from one service to another.

FREE BULLETIN gives complete engineering details and selection data. It features a full color, fully illustrated description of the operating cycle of a Spence Regulator. Send for your copy of this valuable bulletin today.

9

TYPICAL PRESSURE PILOT MODIFICATIONS AVAILABLE		
Type	Delivery Pressure Range, PSI	Normal Accuracy + or −
D	3-150	1 PSI
D5	1-25	½ PSI
W	0-10	¼ PSI
W7	0-3	½ OZ

Spence

WALDEN, NEW YORK

DEPENDABILITY

THE TRUE MONEY-SAVER IN EVERY "BUFFALO" PUMP

OLD FAITHFUL GEYSER, spouting 12,000 gallons of scalding water 150 feet into the air every 66½ minutes, has been a byword for DEPENDABILITY to millions of tourists since its discovery in 1870.

"BUFFALO" PUMPS have an equally strong reputation for dependability with thousands of users. AND THIS MEANS ECONOMY IN EVERY PUMPING JOB It means freedom from costly repairs—and, more important, freedom from long shutdowns, which are the big cost of pump failure.

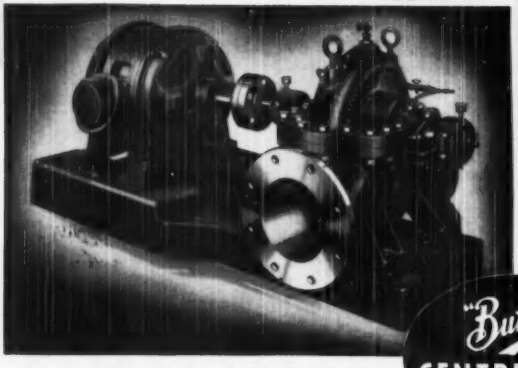
Why take a chance? Back up your liquid-moving jobs with "Buffalo" Pumps and enjoy the true economy in this dependability. Call on your nearby "Buffalo" Engineering Representative for complete information.

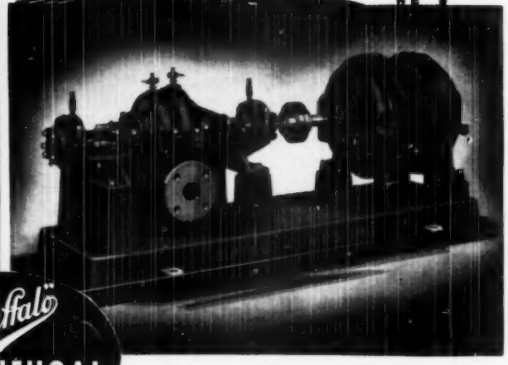
BUFFALO PUMPS INC.

488 Broadway, Buffalo, N. Y.

Canada Pumps, Ltd., Kitchener, Ont.

Branch Offices in All Principal Cities





"Buffalo" CENTRIFUGAL PUMPS

"Buffalo" Class "SL" Pumps are widely used on air conditioning systems and for other clear water service. Write for Bulletin 955-N and see their heavy-duty precision construction.

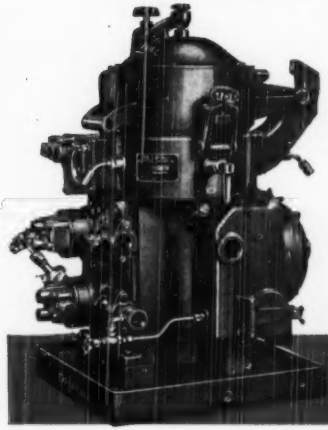
"Buffalo" Class "RR" Pumps for boiler feed and general service are popular with users for their efficiency and durability on the job—in models to deliver from 20 to 900 gpm at heads up to 1500 ft. Write for Bulletin 930-B.

"I am De Laval Centrifugal Force. I keep lube oil—either turbine lube or Diesel lube—both ***clean*** and ***dry***.

"Being able to remove ***both*** contaminants of lube oil at one time gives me an advantage. It means that when I am on the job of protecting a power unit, the engineer never has any worries about dirt or condensate. Whether I am called on to remove a few drops of moisture or quickly to remove a dangerous "slug" of water, I can do it. De Laval machines, properly selected for capacity in the first place, have ample reserve capacity to take care of an emergency.

"When I purify Diesel fuel oil, I enable the operator to get maximum effective usefulness from his fuel oil.

"I'm written up in Bulletin 400 (Turbine Oil) and Bulletin DL-1 (Diesel Oil). Either will be sent on request."



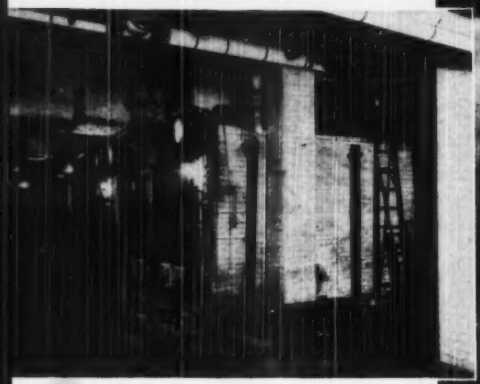
THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

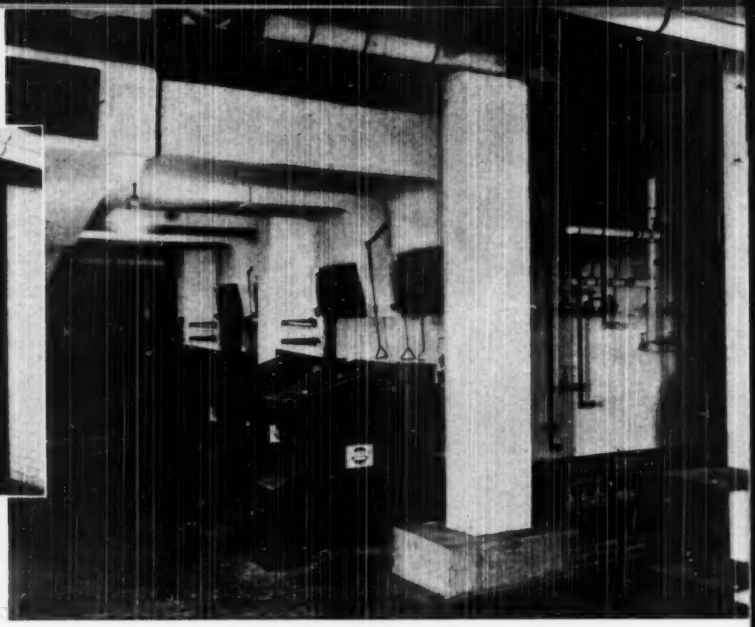
DE LAVAL

Lubricating Oil Purifiers

BELOW: Buffalo (N. Y.) Postoffice Heating Plant before modernization.

RIGHT: After modernization, Canton Stokers make this cleaner boiler room possible.





CANTON STOKERS FIRE NEW HEATING PLANT IN BUFFALO POSTOFFICE

Whatever weather winter brings, the main postoffice in Buffalo, N. Y. is ready for it. Four new boilers, fired by Canton Duraflex Heavy Duty Worm Feed Stokers challenge the biting blasts that sweep across the border.

In addition to the economy, flexibility and dependability of stoker-fired coal, the Buffalo Postoffice enjoys other important advantages peculiar to Canton Duraflex Worm Feed Stokers.

The exclusive Duraflex Sectional Worm will give much longer service because of its heavier alloy steel wall sections. Constructed with a hexagonal steel core inside the cast hub, it is guaranteed against warpage. And, since it is made up of three-inch sections, it is more flexible and individual worm sections can be replaced instead of replacing the entire worm.

The side ash dump makes cleaning quick and easy, eliminates "pulling" clinkers with accompanying dust and fumes. Dumping plates become active grate area between cleaning periods, affording greater capacity and flexibility to meet overload demands and permitting use of lower-priced coals.

Finally, power failure is no concern: all Canton Stokers are designed to permit hand firing in event the electrical current is shut off.

If you are seeking most economical and dependable power and heating, a Canton Stoker Field Sales Engineer can offer you some interesting facts. Write, wire or phone.

CANTON STOKER CORPORATION

714 ANDREW PLACE S. W. • CANTON 1, OHIO

CANADIAN LICENSEES: VOLCANO, LTD., MONTREAL, QUE.

CANTON STOKERS

DURAFLEX WORMFEED
for loads up to 175 H.P.

LO-SET RAMFEED
for loads up to 350 H.P.

VULCAN RAMFEED
for loads up to 800 H.P.

Also

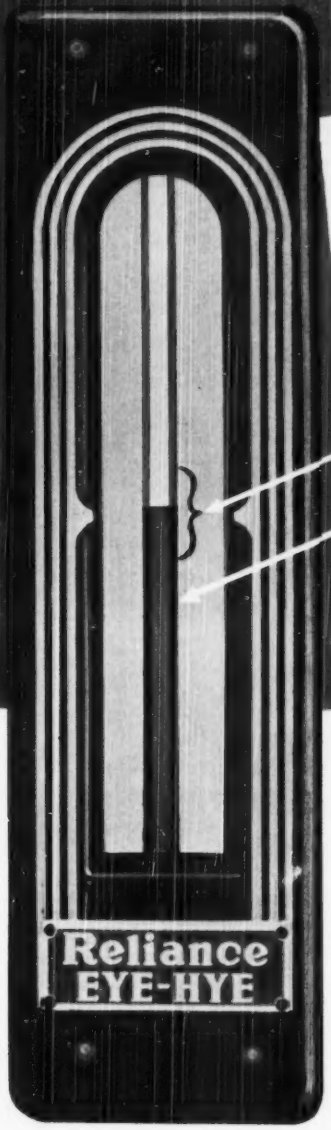
SYNCHRONIZED COMBUSTION CONTROL SYSTEMS
for all boilers

TURBO-AIRE JETS
for smoke abatement, firing efficiency

You Can't Miss!

READ BOILER WATER LEVELS accurately, quickly with Reliance EYE-HYE®

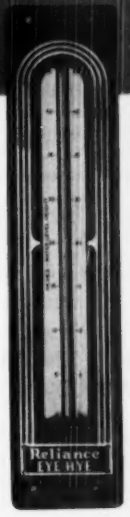
Remote Reading Liquid Level Gage



Sharp contrast between steam and water indication.

Green indicating fluid, illuminated, shows water level more distinctly than the boiler gage.

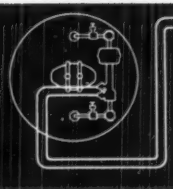
Handsome face plate dresses up any instrument panel.



EYE-HYE is a simple, all-hydrostatic gage you can place above or below boilers and tanks—any reasonable distance—mount the instrument on instrument panel, wall or girder. Rugged construction; no mechanical working parts; easy to install; practically no maintenance. Write today for EYE-HYE literature.

The Reliance Gauge Column Company
5902 Carnegie Avenue • Cleveland 3, Ohio

Graduated scale available showing gallons, proportions, etc.



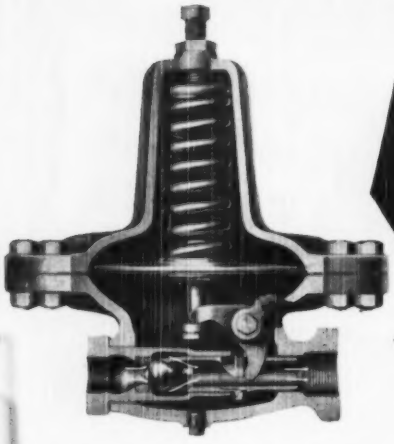
Reliance EYE-HYE
Remote Reading Gage
All-hydrostatic • Reads like a tubular glass gage

10 POINT *Results*

FROM

CASH STANDARD *Streamlined* PRESSURE **REDUCING VALVES** TYPE 1000

THESE TROUBLEMAKERS FIND NO OPPORTUNITY TO PERFORM WITH THE "1000" ON THE JOB



A MANUFACTURER CHECKS THE 10 POINTS AND SAYS . . .

"We have 3 of these '1000' valves and all of them are giving good service."

THE 10 POINTS ARE CHECKED BY A RESEARCH FOUNDATION, THEY SAY

"These valves have been VERY SATISFACTORY BOTH IN OPERATION and MAINTENANCE. The MAINTENANCE COST IS ABSOLUTELY NOTHING once this '1000' valve is installed. Wherever any one may need CONTROLLED PRESSURE IN EITHER STEAM, AIR, or ANYTHING—this CASH STANDARD '1000' valve can be relied upon to do just that and TO GIVE CONTINUED TROUBLE-FREE service."

A MEAT PACKER SAYS IN CHECKING THE 10 POINTS . . .

"Very little maintenance required."

A STEEL CASTING CO. CHECKS THE 10 POINTS—THEY SAY . . .

"We find your CASH STANDARD Streamlined Type '1000' Pressure Reducing Valves to be VERY RELIABLE. We have a number of these valves in service throughout our plant, and have NEVER HAD ONE OUT OF SERVICE for any reason. These '1000' valves have been in service for approximately five years."

A MOULDED PRODUCTS CO. CHECKS THE 10 POINTS AND SAYS

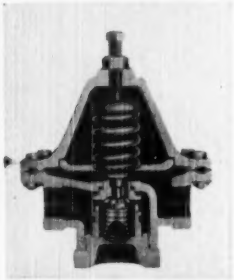
"Maintenance time and cost very low."

These are the Points
USERS CHECK WITH . . .

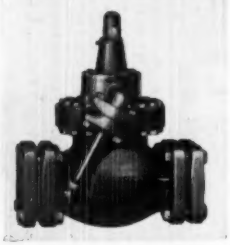
1. **Maximum capacity when needed most.**
2. **Accurate pressure control under toughest working conditions.**
3. **Trouble-free service.**
4. **Smooth operation.**
5. **Tight closure.**
6. **Speedier production results.**
7. **Elimination of failures.**
8. **Cost-saving operation.**
9. **No spoilage.**
10. **Practically zero in maintenance.**

WRITE FOR BULLETIN 962

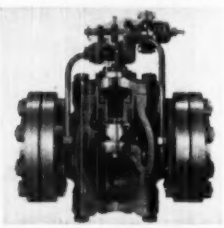
BULLETINS AVAILABLE ON OTHER CASH STANDARD VALVES
Send for them



Bulletin 950—features the CASH STANDARD Type D Single Seat Pressure Reducing and Regulating Valves for use with most fluids. Shows simple inner working parts that save in maintenance. Diagram explains how valve works. Blueprint shows simplicity of installation.



Bulletin 956—features the CASH STANDARD Type 4030 Back Pressure Valve — designed to automatically maintain a constant pressure in the evaporator corresponding to a constant temperature desired. Shows an Ammonia and Freon Gas Capacity Chart based on ABSOLUTE pressures.



Bulletin 966—features the CASH STANDARD Self-Contained, Pilot Operated Type 10 Pressure Reducing and Regulating Valve for use with water or air; with any gas or oil that is non-corrosive; and with refrigerating fluids such as Ammonia and Freon. Many interesting particulars explained such as: how valve works, tight seating, large capacity, no waste, no water hammer or chatter.

CASH STANDARD CONTROLS.. VALVES

A. W. CASH COMPANY
DECATUR, ILLINOIS

HERE'S MOTOR REPAIR SERVICE

THAT WILL SAVE YOU MONEY!

A-C Certified Service Shops, like Cincinnati Electric Equipment Company shown, have modern equipment and expert personnel for fast emergency service . . . for routine maintenance and repair that keeps your production rolling smoothly.

WHEREVER YOU ARE, there is a nearby Allis-Chalmers Certified Service Shop to keep your motors and other electrical equipment running smoothly. These independent shops are selected after careful investigation for their up-to-date equipment, experienced personnel, good business practices and will to serve. They use only factory-approved parts and methods.

When you need repairs or maintenance on motors and other electrical equipment, depend on Allis-Chalmers Certified Service. Write for a list of the Certified Service Shops near you.

For New Motors and Control . . .

No one knows more about correct motor and starter application than your A-C Certified Service Shop. When you need new motors or starters, check with the one in your area or with your nearest A-C Sales Office.

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Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

PUMPS — Integral motor and coupled types. Sizes and ratings to 2500 GPM.

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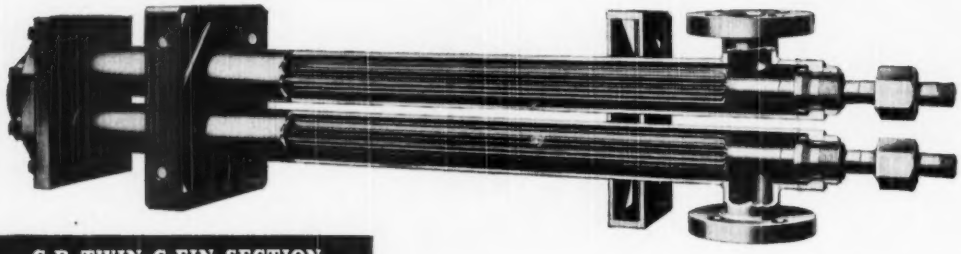
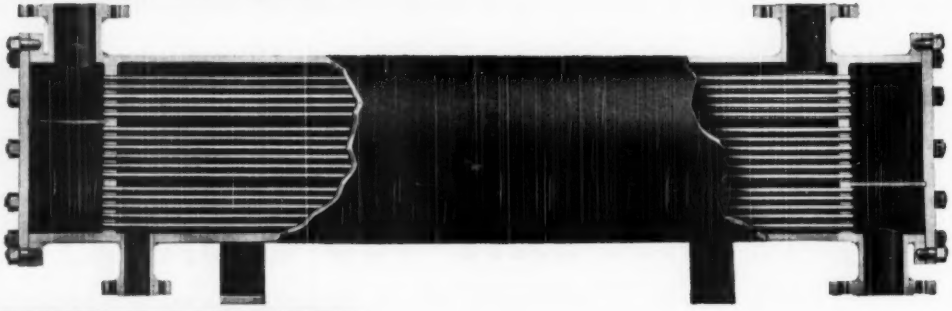
FUEL OIL HEATING



G-R TWIN G-FIN SECTION



G-R TYPE B TUBULAR HEATER

G-R offers you the choice of two different designs of fuel oil heater. Both designs are of long-proven heating effectiveness and dependability. Both designs have readily accessible tube interiors and are easy to keep clean. Both designs are of sturdy construction and are lastingly secure against leakage.

If your requirements are for the heating of large quantities of oil, you want the compact, easily handled G-R Type B Heater.

Where your requirements are for moderate or small quantities, with great capacity flexibility and a minimum of spare equipment, you want the G-R Twin G-Fin Section.

Write for full information on each of these units, and for advice as to the most suitable type of heater for your particular plant conditions.

THE GRISCOM-RUSSELL CO., 285 MADISON AVENUE, NEW YORK 17, N. Y. GR-927

GRISCOM-RUSSELL

PIONEERS IN HEAT TRANSFER APPARATUS

Call in this Remarkable Instrument

TO INCREASE
POWER OUTPUT AT NO INCREASE IN COST

THE Cities Service Industrial Heat Prover is a flue gas analyzer which quickly, accurately and completely determines the heat generating efficiency of equipment using any type of fuel. With this information necessary adjustments to increase efficiency can be made.

A complete new line of petroleum products for the power field including:

- **D-C Diesel Engine Oils**
- **Pacemaker, Turbine and Compressor Oils**
- **Optimus Cylinder Oils**
- **Sentry Plant Machinery Oils**

The Heat Prover gives you the answers to these questions important to efficient production:

1. **How much energy is wasted in uselessly heating excess air?**
2. **How much excess oxygen is present in furnace gases?**
3. **What percentage of fuel is converted into useful heat?**

For a complete description of Cities Service Industrial Heat Prover Service, mail the coupon below for your copy of "Combustion Control for Industry."

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QUALITY PETROLEUM PRODUCTS

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Sixty Wall Tower, Room 561
New York 5, N. Y.
Please send me without obligation your new booklet entitled "Combustion Control for Industry."

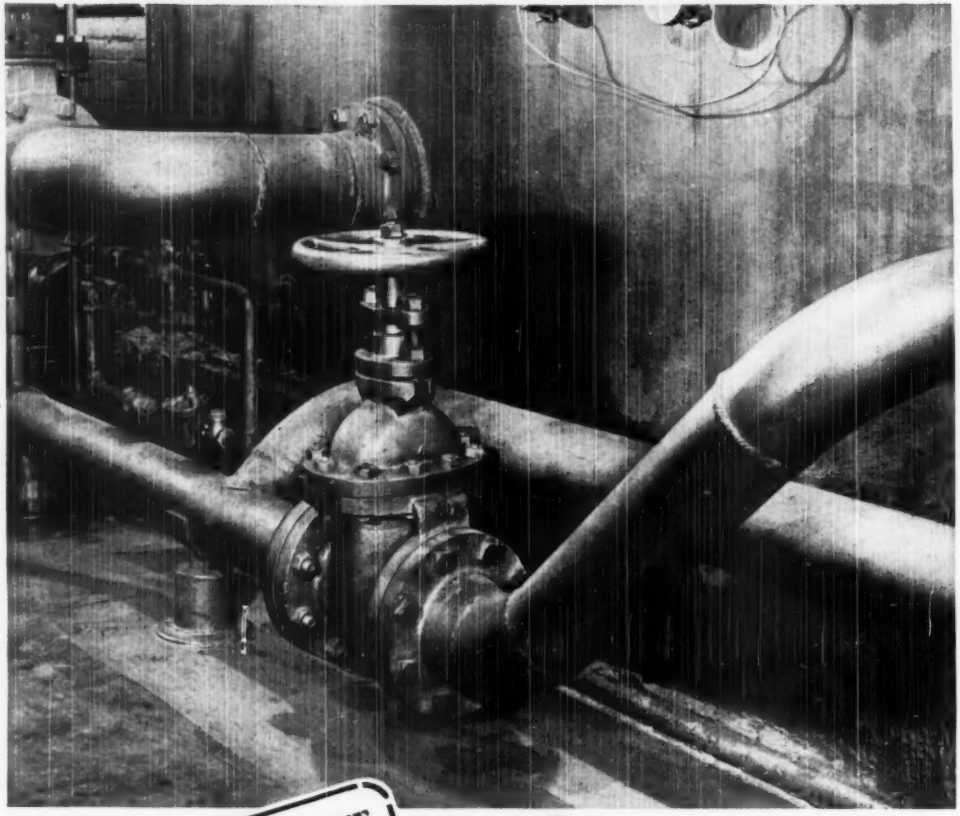
Name _____

Company _____

Address _____

City _____ *State* _____

How to cut corners that cost



ANOTHER JOB DONE BETTER WITH GLOBE WELDING FITTINGS

PIPING "corners" can be costly—costly in initial installation, continual maintenance, flow resistance, pressure-loss, erosion, and corrosion.

You can "cut the corners that cost" with Globe Welding Fittings. Installation is simpler—faster. Your piping is safer, stronger with less weight—needed space reduced—insulation is easier and faster. There is less chance for erosion, corrosion, and leakage to develop because of the smooth inner walls, true radii and circularity of Globe Welding Fittings. Liquids and gases flow smoothly with less resistance and pressure-loss.

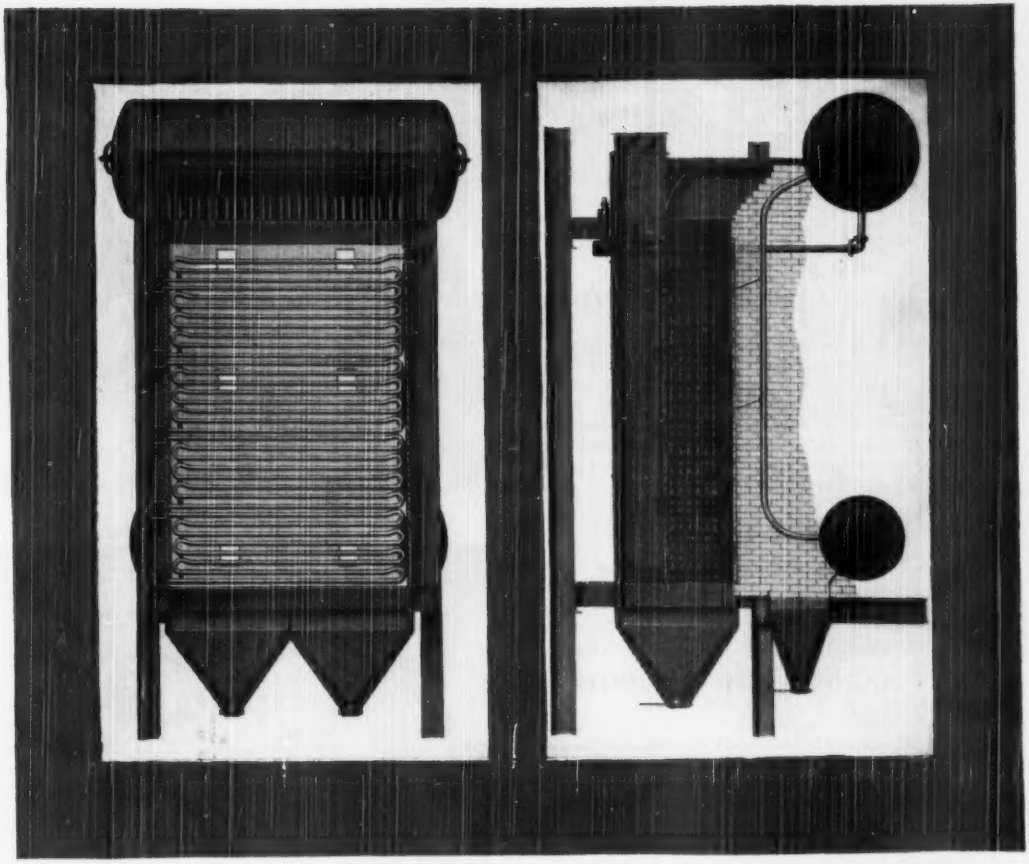
Decide to "cut the corners that cost" on your next piping job—specify and use Globe Welding Fittings, produced from Globe seamless steel tubes by the Globe Precision Process.

GLOBE STEEL TUBES CO., Milwaukee 4, Wisconsin

Producers of Globe seamless stainless steel tubes — Gloweld Welded stainless steel tubes — carbon — alloy — seamless steel tubes — Globeiron seamless high purity ingot iron tubes — Globe welding fittings.

For complete information on sizes and types send for Globe Welding Fittings Catalog.

GLOBE PRECISION PROCESS WELDING FITTINGS



THE ERIE CITY ECONOMIZER

In this Erie City continuous loop, forced circulation Economizer, feed water is forced into the lower left header, travels thru sectional loops upward and is collected in the discharge header at the upper right. Flue Gas enters the top of the Economizer and travels downward, counter to the flow of water. The resulting rise in the temperature of the entering feed water and the corresponding reduction in gas exit temperature increases the overall efficiency of the generator. All pressure parts are supported with suitable clearance for expansion. Headers are firmly attached and serve as anchor points. Each element is free to expand or contract to meet its individual temperature requirements. Intermediate headers are provided to permit making the elements with a moderate number of short standard loops. This reduces the number of spares required and facilitates replacement.

For a detailed description of this and all other unit parts of our Erie City Steam Generator request Bulletin SB-30, a 40 page catalog.

COMPLETE STEAM POWER PLANT EQUIPMENT

ERIE CITY

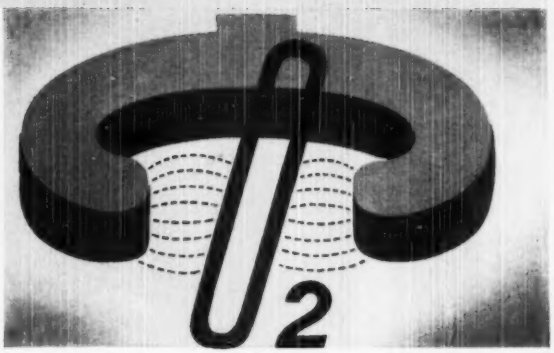
Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*

SIX REASONS WHY HAYS

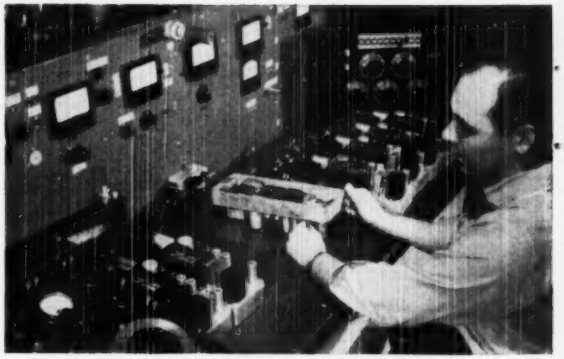
1 HAYS WAS ONE OF THE FIRST TO RECOGNIZE AND APPLY THE PARAMAGNETIC PRINCIPLE

As early as 1909 Joseph Hays recognized the need for an Oxygen Recorder. During the next thirty years at least five oxygen analyzing instruments (each based on a different principle) were built, tested, and discarded. It was not until the early years of World War II that Hays' research engineers felt they had a principle worth complete exploitation—the paramagnetic qualities of Oxygen. Then followed . . .



2 MONTHS OF CONTINUOUS LABORATORY RESEARCH

Once it had been established that magnetically induced thermal resistance changes accurately mirrored O_2 content changes in a gas sample, it was necessary to procure an amplifying circuit capable of millionfold amplification. Tests on existing amplifiers revealed them to be inadequate, so Hays engineers designed and built their own unit. When both the Analyzer and Recorder were complete, it became clear that Hays had an instrument with unequalled . . .



3 PRACTICAL DESIGN FEATURES

Positive, immediate zero check through use of free swinging magnet. High sensitivity, rapid response to O_2 changes plus advantages of rugged construction.

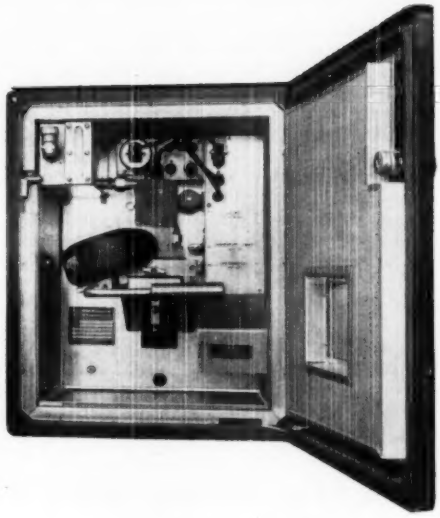
Patented compensator makes readings accurate in % O_2 by correcting for changes in barometric and gas sample pressure.

No chemical required . . .

No combustion . . . complete safety.

No gaseous or liquid fuels added to gas sample.

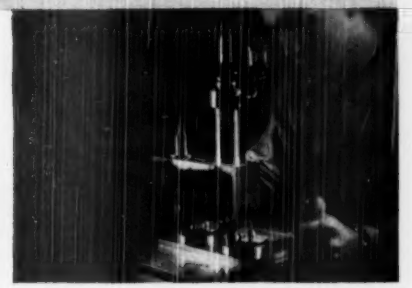
Provision for as many as 4 records on one chart.



= O_2 LEADERSHIP

4 PAINSTAKING, PRECISION FABRICATION

High accuracy and sensitivity require close tolerances, and new production problems arose. Hays production experts solved these problems by investing large sums in new jigs and machines, by building their own equipment not available elsewhere, and by using their 40 years of instrument manufacturing "know-how". When finished, the new O_2 Recorders were subjected to . . .



5 FOUR YEARS OF INTENSIVE FIELD RESEARCH

Test installations were made in the oil, steel and glass industries as well as in power plants and laboratories. Field engineers covered the U. S., noting instrument performance under varying conditions, and then worked with research personnel to translate their findings into product improvements. New compensations, calibrating techniques and adjustments were worked out, with the result that Hays has a wealth of . . .

6 APPLICATION "KNOW-HOW"

No theorists, Hays field engineers possess a rich background of experience in applying the Magno-Therm O_2 Recorder to catalyst regenerators, process heaters, heat treating furnaces, open hearths, government research laboratories and similar operations. You benefit by their knowledge gained in working with 200 leading industrial users . . .

Bulletin 49-829 free for the asking, describes the principle and operation of this instrument . . . write for it!

THE HAYS CORPORATION
Michigan City 3, Indiana

Please send me Bulletin 49-829 which describes the Hays Oxygen Recorder and Analyzer.

Name_____

Company_____

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MICHIGAN CITY, INDIANA, U. S. A.

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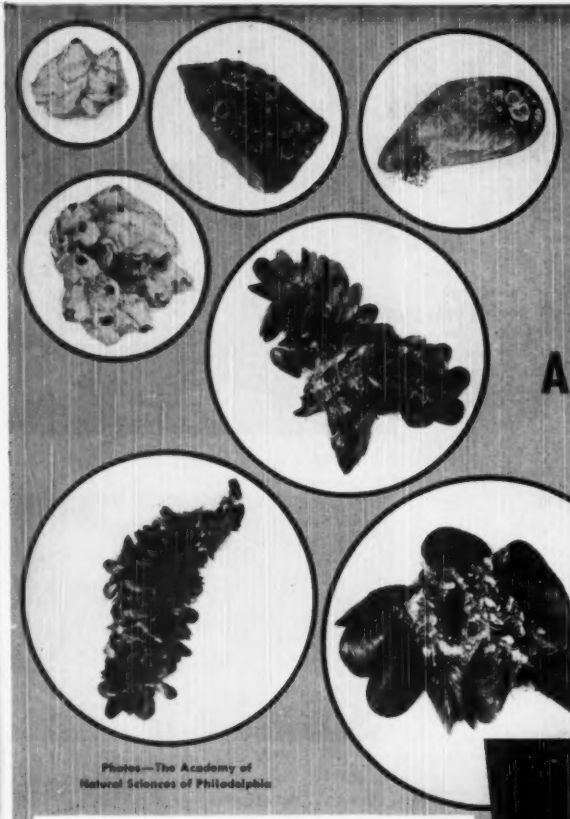


A Condenser Tube is NO Home for

MYTILUS EDULIS,* ALGAE or BARNACLES

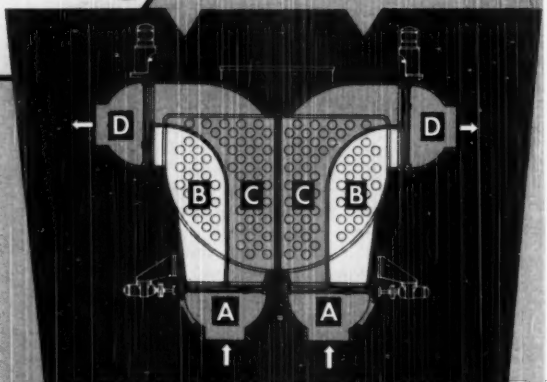
when you have C.H. Wheeler "Reverse Flow" Condensers

*Edible sea mussels

Photos—The Academy of Natural Sciences of Philadelphia

Mytilus edulis and barnacles illustrated here present a vivid picture of what they can do to condensing tubes when permitted to grow and multiply. These pests are constant troublemakers and are said to be more harmful to efficient heat transfer than any other cause of tube clogging, including algae and other fresh water organic and inorganic matter. But there's an easy, quick and economical way to rid your condenser of these sea and fresh water obstructions during operation and without loss of vacuum by using the patented C. H. W. "Reverse Flow" method. Higher temperature of the water plus the high velocity flushing action of full reverse flow successfully attacks both sea and fresh water pests, as well as any other debris that gets by screens. And you'll be surprised at the money you can save on maintenance, too. Many are now in service ranging in size from 10,000 sq. ft. up. Write for more information on how to prevent tube clogging by marine and fresh water pests with C. H. W. "Reverse Flow" Condensers.

C. H. WHEELER MANUFACTURING CO.
1800 Sedgley Avenue, Philadelphia 32, Pa.
REPRESENTATIVES IN MOST PRINCIPAL CITIES



In the operation of a C. H. W. "Reverse Flow" Condenser, with divided water box, water enters valve chamber at A with left hand valve port open to permit water to flow through pass B, then changing direction at other end of condenser and flowing back through pass C and out through the upper port of D. To reverse flow, valves at inlet A and discharge D are changed to permit water to flow through C first, returning through B and out through the lower port of D. Both halves of the condenser are operated in similar manner, but independently of each other.

C. H. Wheeler SINCE 1903

STEAM CONDENSERS · WATER COOLING TOWERS
EJECTORS · STEAM JET VACUUM REFRIGERATION
OF PHILADELPHIA

Paris gets 215,000 more kw's; KELLOGG provides all critical power piping!

ALONG with the need for rebuilding and expanding Europe's industrial capacity, there is a corollary need for more efficient power production, calling for higher operating temperatures and pressures. As these conditions approach and exceed 1,000°F. and 1,700 p.s.i., piping naturally becomes a major problem, demanding the most modern techniques for satisfactory solution.

For example, piping layouts for the two new 100,000 KW main turbines now installed at Gennevilliers Station were first checked on Kellogg's exclusive apparatus for determination of stresses under operating conditions.

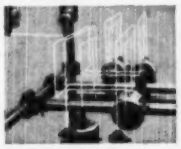
But correct design is only one part of the problem resulting from the demand for higher efficiencies. These critical conditions call for special alloys, requiring expert fabrication and installation . . . they necessitate the creation of special devices, such as bi-metallic transition pieces that, to date, have been made only by Kellogg. And they make the quality of on-the-site stress relieving and non-destructive inspection of alloy welding a prime consideration.

Kellogg has proven its power piping techniques in providing complete piping systems for high pressure and high temperature installations producing millions of kilowatts—of which more than 600,000 KW represents plants outside the United States. Currently, Kellogg is working on numerous power projects in Europe, South and Central America as well as in the U. S. Because of these widespread activities, Kellogg's experienced fabrication and installation crews are readily available to virtually any power producer throughout the world.

Special studies of unusual problems such as graphitization to assure long life and low maintenance.

Metallurgical research by recognized specialists who have made major contributions in this field.

M. W. KELLOGG



Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations.

Complete facilities for the fabrication of steel products from simple forgings to specially cast bi-metallic devices.

Top welding performance in shops and in the field by welders accustomed to working under X-Ray checks.

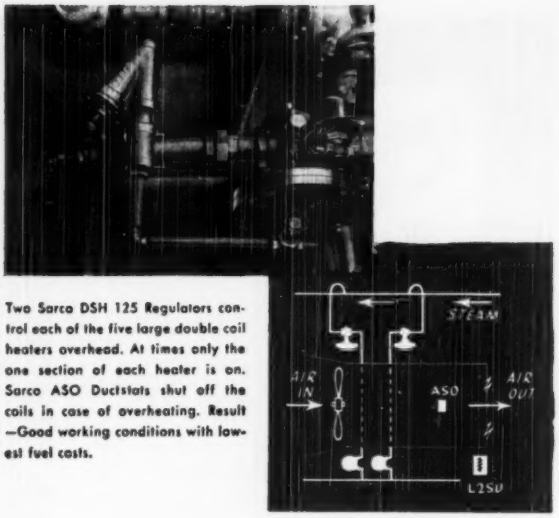
Quality control, devised by metallurgical experts, embracing forming, heat treating and non-destructive testing.

Vessels
Exchangers
Condensers
Process Piping
Forged and Welded Fittings
Radial Brick Chimneys

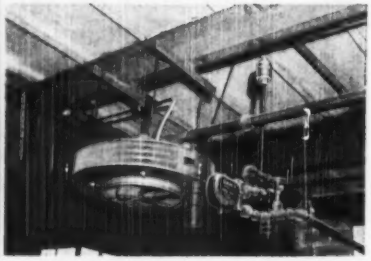
The M. W. Kellogg Company, Inc. (A Subsidiary of Pullman, Inc.) — Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris

ARE YOUR HEATERS

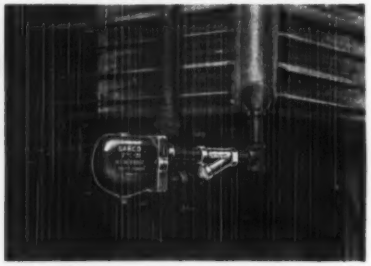
Getting a Break?



Two Sarco DSH 125 Regulators control each of the five large double coil heaters overhead. At times only the one section of each heater is on. Sarco ASO Ductstats shut off the coils in case of overheating. Result —Good working conditions with lowest fuel costs.



At Broadvue Motors, Cleveland, Ohio—large doors let in cold at irregular intervals. Here Sarco Electric Thermostat and Float Trap keep the rooms comfortable without unnecessary heat.



Down blast unit heater dispels mist in dye room. Sarco Float Thermostatic Traps and Sarco Strainer ideal for continuous jobs like this.

No matter how carefully you select and locate the unit heaters to fit the job to be done, complete satisfaction cannot be assured unless you also take care of the vital factors:

1. Use the right steam trap and air vent to keep the heater surfaces in contact with hot, dry steam, and remove condensate and air rapidly and completely.

2. Provide simple but effective Sarco Controls to start and stop the fans as required, or to modulate the steam supply to the heaters.

At the left—two simple examples of unit heater efficiency. You can get 10 to 30% more out of your heaters by spending 1 or 2% of their cost for suitable Sarco Steam Traps and Controls. Ask for special information on unit heater hook ups.

OR BETTER YET — ASK THE SARCO MAN NEAR YOU

256

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SARCO CANADA, LTD., TORONTO 5, ONTARIO

IMPROVES PRODUCT QUALITY AND OUTPUT

POWER

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Westinghouse

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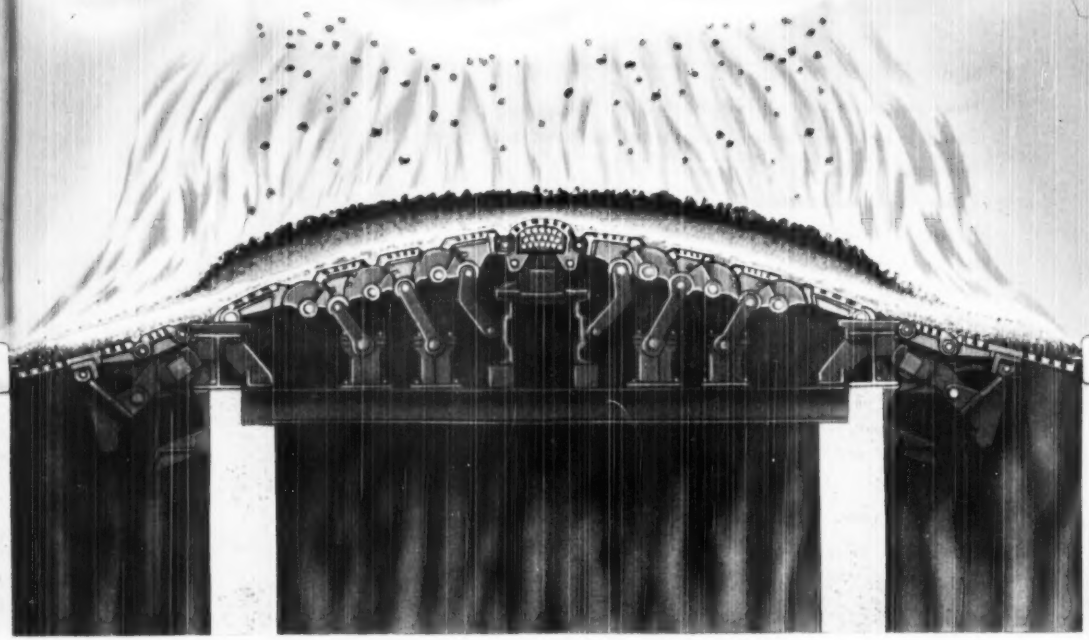
with *Link-Grate*



...Unique Spreader-Type Firing Brings Traveling-Grate Performance to the Dump-Grate Field

The Centrafire principle of spreader firing distributes the fuel *continuously* over the central portion of the grate.

A generous part of the fuel burns in suspension. The remainder thoroughly burns on a porous, inclined fuel bed. Burning fuel and accumulating refuse progress constantly toward the ash-discharge grates along the side walls.

The drive is simple, rugged and trouble-free . . . one motor or turbine operates all moving parts through a constant-speed oil pump.

The Centrafire with Link-Grate may readily be applied to the boiler of your choice within the base-load capacity range of 25,000 to upwards of 50,000 lbs. of steam per hour.

The Centrafire is backed by over 60 years of Westinghouse fuel burning know-how and a nationwide service organization eager to see that you get optimum operating economy from your Westinghouse firing equipment.

* * *

GET THE FULL FUEL-SAVINGS STORY...

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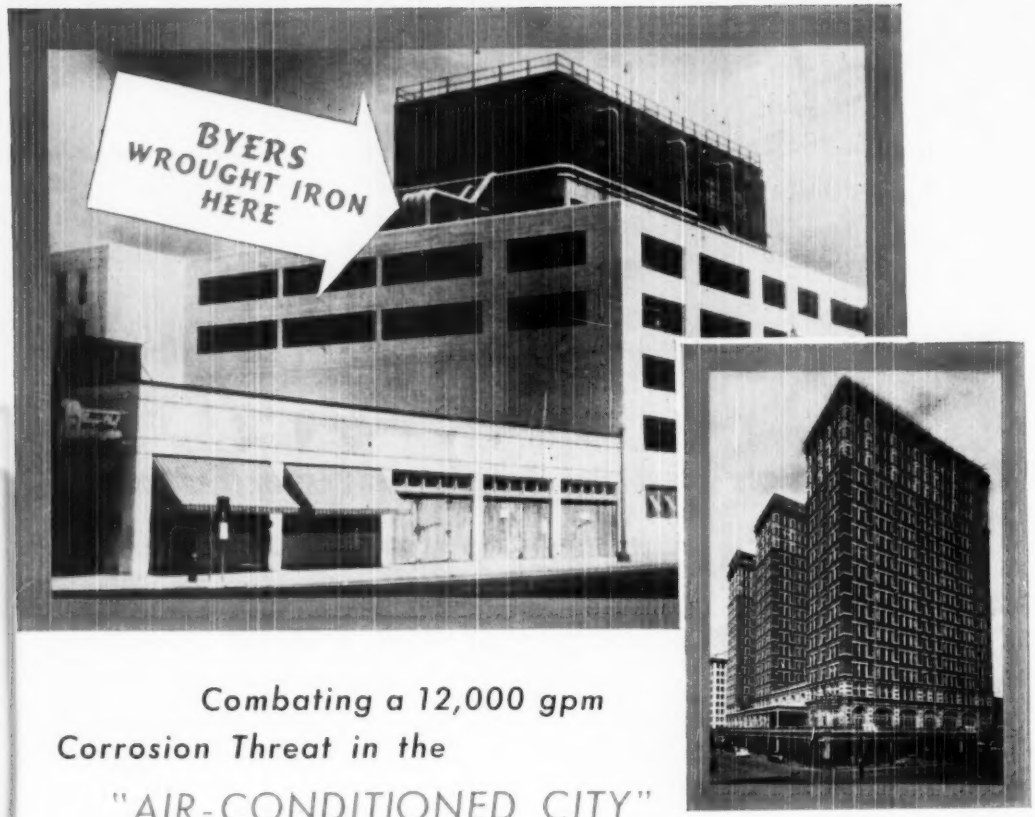
Westinghouse

STOKERS



Combating a 12,000 gpm Corrosion Threat in the

"AIR-CONDITIONED CITY"

To completely air-condition the 1000-room Rice Hotel at Houston, Texas, 12,000 gallons of water per minute must be circulated between the engine room and the giant cooling tower on the roof of the hotel garage, 700 feet distant. To combat the inescapable corrosive attack, the engineers used Byers Wrought Iron plates in fabricating the 18-inch pipe which handles the flow. A substantial quantity of Byers Wrought Iron pipe was also supplied for cooling and condenser water lines within the hotel building.

Houston, which claims more air-conditioning than any other city in the world except Washington, D.C. calls itself the "Air-Conditioned City". This concentration of installations gives engineers and users ample opportunity to determine the worth of various materials. It is significant that wrought iron appears in practically every specification.

The durability of wrought iron in services like these comes from the unusual character of the material. Tiny fibers of glass-like silicate slag, threaded through the body of high-purity iron, halt and "detour" corrosive attack. The fibers also anchor the initial protective scale, which shields the underlying metal just as a scab protects a wound.

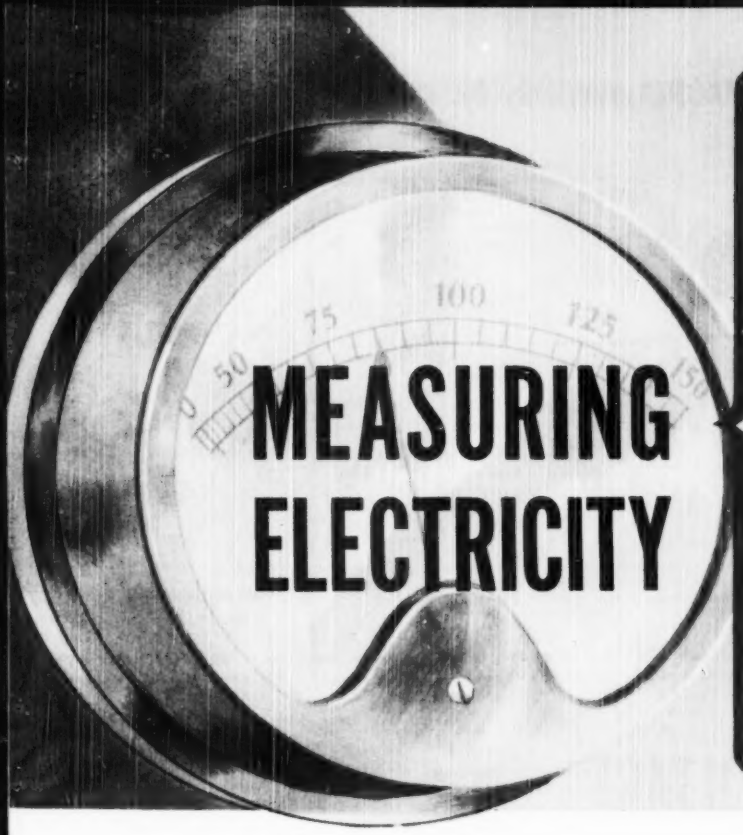
If you are contemplating any air-conditioning installations, or are concerned with the maintenance of any existing systems, you will find some helpful information on the use of wrought iron in our bulletin, WROUGHT IRON IN REFRIGERATION, ICE SKATING RINKS AND AIR-CONDITIONING SYSTEMS. Ask for a complimentary copy.

J. RUSS BATY, Architect on Hotel Garage; REG F. TAYLOR, Consulting Mechanical Engineer; CHAS. G. HEYNE & CO., Mechanical Contractors on Air Conditioning; KANE BOILER WORKS, Fabricators of 18" pipe; O. W. ROSIN, Chief Engineer, Rice Hotel.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, Salt Lake City, San Francisco. Export Division: New York, N. Y.

CORROSION COSTS YOU MORE THAN WROUGHT IRON

BYERS
GENUINE WROUGHT IRON
TUBULAR AND HOT ROLLED PRODUCTS
ELECTRIC FURNACE QUALITY ALLOY AND STAINLESS STEEL PRODUCTS



MEASURING ELECTRICITY

CURRENT
VOLTAGE
RESISTANCE
POWER
ENERGY
DEMAND
POWER FACTOR
PHASE RELATION
FREQUENCY

By **J J O'CONNOR,** *Assistant Editor*

Electricity is unique as a power medium. It has neither weight nor shape. It is invisible, and cannot be measured by conventional scales, rulers, pressure gages, thermometers or flowmeters. Yet all precise electrical knowledge, forming the basic structure of electrical engineering, is an outgrowth of accurate measurement.

Looking at measurement from the broad point of view, we find it comes into the picture in just about every phase of modern living. Whether a housewife is doling out ingredients for a holiday cake, or an engineer controlling load on a turbine-generator, both lean heavily on measurement for ultimate success of the job at hand. This applies even more in measuring electricity since we are dealing with an intangible quantity.

Our aim in preparing this special section (POWER's 74th) was twofold. First, to dispel much of the mystery that has built up around electrical instruments and meters. Second, to lay before the power engineer the few principles that form the working nucleus of electrical measurements. This latter theme was broadened to include the practical matter of putting these measuring devices to work.

On the other hand, no attempt was made to cover purely laboratory problems. Nor did we try to reach the level of the engineer whose sole concern in industry is the test and calibration of electrical instruments and meters. But we did emphasize matters connected with the practical use of electrical measuring tools. This information is of prime importance to the operating man.

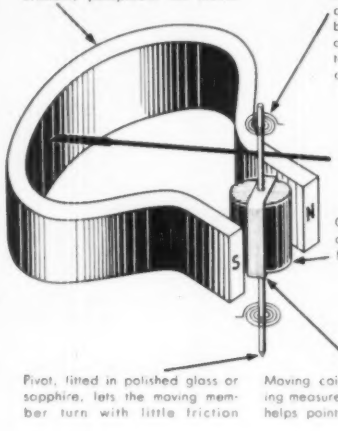
Hence, this special section should serve as a ready reference and easy-reading refresher on instruments and meters met in the everyday job of measuring the electrical quantity.

Throughout this discussion the term *instrument* is confined to devices that measure present values, such as ammeter, voltmeter and wattmeter. Where time is involved, as in watthour and demand devices, the term *meter* is used. This conforms to general practice.

$$I\ (\text{amps}) = \frac{E\ (\text{volts})}{R\ (\text{ohms})}$$

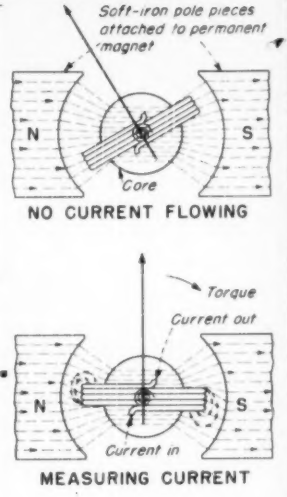
PERMANENT-MAGNET MOVING-COIL INSTRUMENT MEASURES...

THE BASIC PARTS...


Permanent magnet sends a steady flux through core of the moving element; polepieces not shown
Springs oppose moving coil's torque, letting the pointer position be a true index of current being measured. They also carry the current to and from moving coil.
N
S
Core made of soft iron concentrates magnetic field within the coil
Pivot, fitted in polished glass or sapphire, lets the moving member turn with little friction
Moving coil carries current being measured. Its aluminum frame helps pointer come to rest fast

1 **With no current in coil, springs hold the moving element so one side of coil is near edge of adjacent pole face**

WHY IT TURNS...



2 **Magnet and coil flux join at coil sides to develop torque**

CURRENT AND VOLTAGE

Determining the value of direct current is the first and basic step in electrical measurements. Usually a permanent-magnet moving-coil combination does the job, Fig. 1. This fundamental device is often called a D'Arsonval instrument because it resembles the galvanometer, which has a similar movement. But the first practical ammeter using the permanent-magnet moving-coil idea was designed by Edward Weston in 1888.

This moving-coil instrument is for use on dc only. If hooked into an ac circuit the pointer simply vibrates at the zero position on the scale. But, as explained later, when used with a thermocouple or rectifier, it can handle ac measurements.

Construction Details. Since this is our basic instrument let's look further into its makeup. Taking off from the simple sketch in Fig. 1, we find carefully shaped soft-iron pole pieces are attached – sometimes welded – to ends of the horseshoe-type permanent magnet. Hence, the coil moves in a radial field. A nonmagnetic yoke is then attached to the pole-pieces. This supports the shaft and the moving coil. Our picture is rounded out with pivots, jewels, pointer and balance weights.

Fig. 2 tells what makes the pointer move. So skipping that, let's look at the control springs. These are two flat spiral springs, one above and one below the coil. Their dual purpose is to (1) set up an opposing force to the twisting action produced in the coil when a current flows through it (2) serve as electrical conductors to and from the moving coils.

Just so the moving coil may turn with as little friction as possible, pivots above and below the moving element are fitted into highly polished jewels. Generally sapphires are used but some manufacturers now find polished glass more effective.

But whether sapphire or glass, these bearing surfaces may be easily damaged. If an instrument is dropped or jarred, pressure on the jewel may run up to many tons per square inch. This is true even though the moving system itself is extremely light. Added pressure may mean a flattened pivot or perhaps a fractured jewel.

Instrument pointer shows how much current is flowing in the moving coil by the position it takes above the calibrated scale. In high-accuracy instruments, a mirror is fitted under the pointer, right alongside the scale marking. This helps the fellow who is reading the unit to align the knife-edge pointer with pointer reflection. If he finds reflection and needle don't line up, it means eyes and needle are not in a plane perpendicular to scale. This, of course, causes an error in reading.

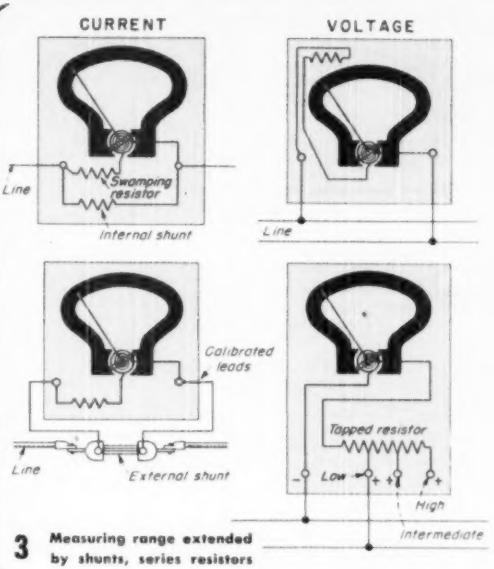
Damping and Shielding. Moving coil is wound on an aluminum frame. That frame has another job in addition to merely supporting the coil winding. It damps the coil. *Damping* is the term that describes control of the swinging motion of moving system so the pointer comes to rest quickly. If the instrument wasn't damped, the pointer would oscillate before coming to rest.

Coming back to our aluminum coil frame again. When the moving coil twists, a voltage is induced in this frame since it cuts magnetic lines from permanent magnet. And it is this voltage that causes a current flow in the frame. In turn a magnetic field is produced opposing the coil's movement. This action brings coil to a quick stop.

It stands to reason that stray magnetic fields will affect the accuracy of this type instrument. Any outside source of magnetism may aid or oppose the field of the instrument

...CURRENT AND VOLTAGE IN DC CIRCUITS

HOW TO USE...



3 **Measuring range extended by shunts, series resistors**

magnet. This would result in a coil torque differing from that intended by the instrument designer.

On the other hand, if a chunk of magnetic material is close up to the device, some of the magnetic flux from the instrument's permanent magnet may be diverted through it. That, of course, would change the field strength, giving an incorrect indication of the coil current.

Here's what all this amounts to: By proper shielding of the unit these errors are avoided. Shielding means closing the magnet and moving coils in a cup or shield of soft iron or other high-permeability material. This provides a path for outside magnetic fields. Shielding is incorporated in practically all modern instruments.

So far we've talked about measuring current. This ammeter, and those still to be described will also measure voltage if used with a series resistance, Fig. 3.

ALTERNATING CURRENT

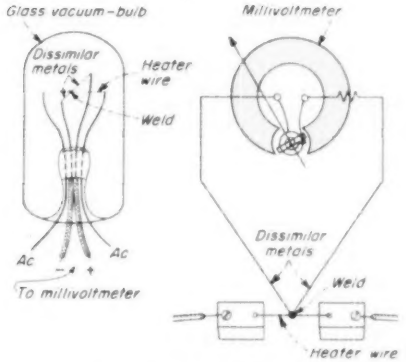
Our same fundamental instrument may be used for ac measurement by incorporating a thermocouple or rectifier. Thermocouple-type unit is nothing more than our old permanent-magnet friend tied into a thermocouple, Fig. 4. The thermocouple, in turn, is welded to a heater strip. Any current passing through the heater strip raises strip temperature. This, in turn, shows up as a dc voltage in the thermocouple and is passed on to the instrument.

Hence, it can, in that way, be calibrated in terms of current flowing in the ac circuit. Such instruments come in handy for high-frequency measurement; say, from 10,000 cycles up into radio frequency. Limit of the current handled is merely a matter of selecting the proper-size heater.

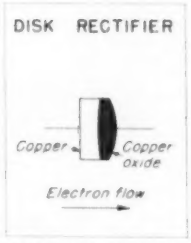
Once again we find the same device used in conjunction with a rectifier, Fig. 5. Here it is simply a matter of connecting the instrument directly across output terminals of a disk-type rectifier. If proper resistance is hooked in series with rectifier on the ac side, we're all set to measure ac voltage.

This setup comes into the picture whenever the power taken by the measuring instrument itself is an important factor. Hence, the rectifier unit combination is useful in communication circuits where it is important to keep the instrument current to a minimum.

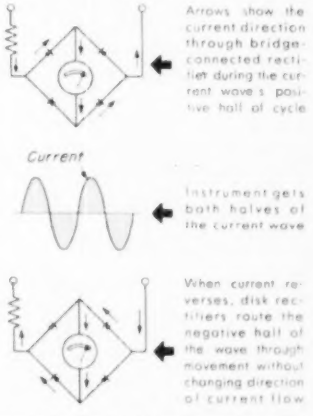
UNIT MEASURES AC WITH THERMOCOUPLE OR RECTIFIER



4 **Vacuum and open-air thermocouple. Used with permanent-magnet instrument for high-frequency work**



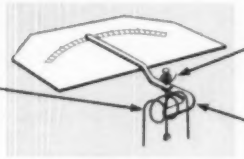
Rectifier instrument's sensitivity is many times greater than that of the moving iron or thermal


Arrows show the current direction through bridge-connected rectifier during the current wave's positive half of cycle
Current
Instrument gets both halves of the current wave
When current reverses, disk rectifiers route the negative half of the wave through movement without changing direction of current flow

5 **Permanent-magnet instrument, fitted with rectifier, draws but little current and is suited for audio-frequency measurements**

MOVING-IRON INSTRUMENTS FOR MEASURING AC

Simple plunger action is the basis for solenoid instrument. Pull on the soft-iron core is related to value of current flowing in coil. Magnetic field acting on moving iron tends to move it into the position resulting in a maximum flux within coil



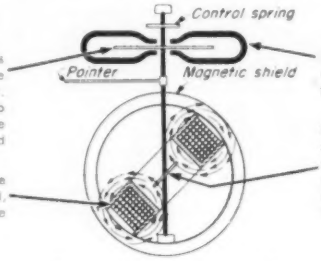
Current being measured goes through solenoid only. So control springs only job now is opposing normal torque developed

Soft-iron armature always pulled into solenoid regardless of direction of current flow through it

6 In contrast to moving-coil type, Fig. 1, moving-iron instruments have a fixed coil and soft-iron member, with shaft and pointer attached, that's free to move

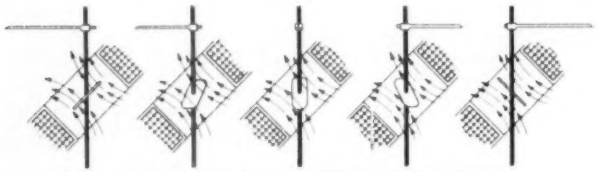
Aluminum damping vane is attached to shaft on the opposite side of pointer. Beside its damping job vane also helps keep the moving element balanced

Field coil, carrying the current being measured, is set at 45-deg angle



Field for aluminum damping vane is supplied by two permanent magnets

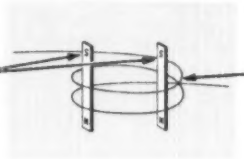
Elliptical soft-iron vane attempts to align itself with field produced by surrounding coil. Torque developed is opposed by the control spring above



Relation of moving vane to coil for 180 deg rotation of shaft

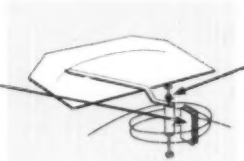
7 Inclined-coil is another member in the moving-iron family. Provides a long, well-distributed scale in both ac portable and switchboard-type instruments

Repelling force produced between two like poles utilized to move pointer



Both vanes magnetized alike so torque is independent of current direction

Moving vane rotates with shaft until the torque, developed by repelling vanes, is balanced by the springs' counter-torque

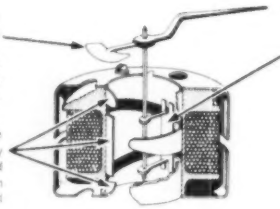


With no current in field coil, control spring holds movable and fixed vanes together. Pointer, attached to shaft, rests at zero

8 Operation of repulsion instrument depends on repelling force set up between two adjacent pieces of soft iron that are subjected to the same magnetic field

As with other moving-iron instruments, a separate damping system is used. In this case flux comes from 10 separate magnets embedded in half-rings

Field coil surrounds three wedge-shaped stationary vanes that are magnetized as consequent poles when the current flows in coil



Movable vane is first repelled from wide end of the middle stationary repulsion vane, Fig. 10. Repelling force decreases as movable vane travels along tapering middle vane. Force of attraction increases as ends of the moving vane come closer to upper and lower vanes

9 Here we find attraction and repulsion principles applied in the one device. Soft-iron cups supply the magnetic shielding necessary for accurate operation

Stepping into the field of alternating-current measurement, the first instrument we meet, the moving-iron type, is quite different from the permanent-magnet unit discussed on the preceding two pages. No permanent magnet is used to develop torque in this instrument. Coil through which measuring current flows is fixed in position on the instrument frame.

Solenoid and Plunger. A field coil, a pivoted soft-iron plunger, and a control spring are the basic parts, Fig. 6. Current to be measured passes through the field coil. Solenoid action draws the soft-iron plunger into coil until force is balanced by opposing control spring.

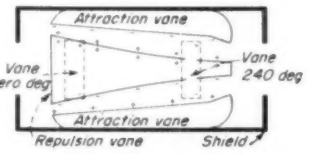
Variation on the moving-iron idea is the *inclined-coil* type shown in Fig. 7. This construction is often used in both portable and switchboard instruments providing a long, well-distributed scale. In this instrument the vane is parallel to inclined-coil axis. When current is sent through coil, a magnetic field is produced. Resulting turning action comes from the vane trying to align itself with the magnetic field.

Other moving-iron schemes are shown in Fig. 8-10.

Damping. Do you recall how the aluminum frame on the moving coil was used as the damping medium in the permanent-magnet movement? Well, the two methods often used in moving-iron instruments are magnetic and air-damping, Fig. 14.

Magnetic damping is handled by supporting a thin aluminum or copper vane between poles of a permanent magnet. When element turns, the damping vane cuts damping-magnet flux. A current is induced in the vane, setting up a magnetic field around it. This field reacts with the permanent-magnet field, bringing it quickly to rest.

Air damping, in a nutshell, depends on resistance that air sets up in a closed chamber. Although air damping involves more precise construction than its magnetic brother, we can get a higher value of damping.



10 Development of repulsion-attraction unit showing polarity with dc field

Probably the next question you have in mind is, "Can we use all moving-iron instruments for both ac and dc measurements?" Yes, but they are primarily used for ac measurement. When used on dc they are less accurate and sensitive than their permanent-magnet brothers.

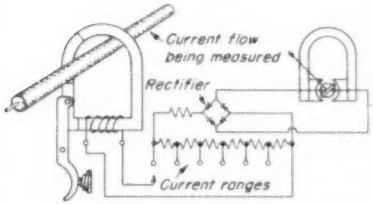
Dynamometer Movement. While moving-iron types are cheaper, more rugged, the most accurate practical ac instrument employs the electrodynamometer movement. This latter type is thus often used as a transfer for calibrating moving-iron instruments from laboratory potentiometer readings. The dynamometer instrument gets its twisting motion as a result of the action between the fields of the moving coil and fixed coil, Fig. 12

To measure small currents, both coils in the dynamometer instrument are connected in series. When used this way for current measurement, the element is generally rated at not more than 100 milliamperes — a practical limit for current in the lead-in spirals.

But what about measuring larger values of current? Well, it's not practicable to shunt the instrument as in the dc case. One reason is that resistance of two coils in series will be so great, an excessive voltage drop will be needed across the shunt. The instrument-design boys got around this problem by modifying the connection somewhat, as shown in Fig. 12.

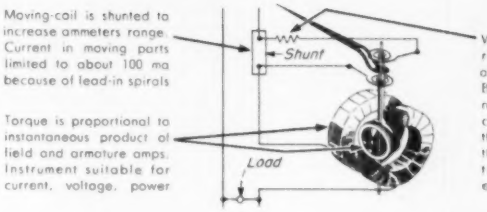
Measuring Voltage. Now we can use our two coils connected in series if the job calls for measuring voltage. All that is needed then is a suitable series resistor to limit current-flow to the instrument's maximum rating.

Keep in mind that the sensitivity of the dynamometer-type voltmeter is generally less than that of permanent-magnet instrument. One reason is the larger current required by the dynamometer element. When compared with the moving-iron instrument, however, it is much more efficient and better adapted to service requiring high accuracy.

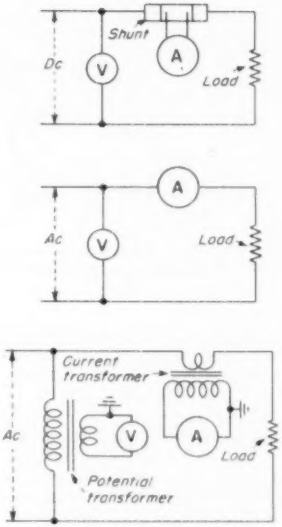


11 **Split-core ammeter uses rectifier and a permanent-magnet instrument**

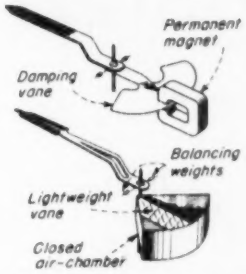
DYNAMOMETER MOVEMENT AND TYPICAL HOOKUPS


Moving-coil is shunted to increase ammeters range. Current in moving parts limited to about 100 ma because of lead-in spirals
Torque is proportional to instantaneous product of field and armature amps. Instrument suitable for current, voltage, power
Shunt
Load
When temperature rises, resistance of the copper armature winding goes up. But swamping resistor has near zero temperature coefficient. As value of this resistance is greater than armature, change in temperature has little effect on the current flow

12 **The simple dynamometer movement above may be adapted for measuring voltage by connecting a resistor in series having negligible temperature coefficient**

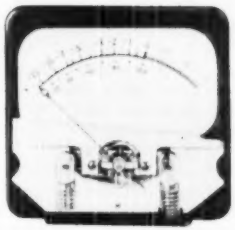


13 **Typical instrument connections. Note grounds on transformer secondaries**

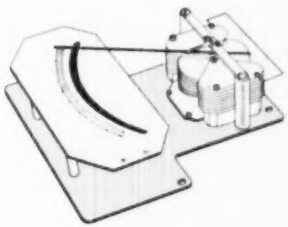


14 **Magnet-vane and air-chamber are used to damp out pointer oscillations**

15 **Moving-iron voltmeter designed for easy reading over 90% of full scale**

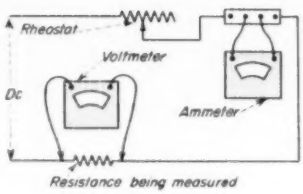


16 **Reflected light from two lamps shines on standard metal dial**

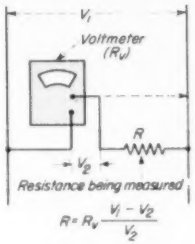


17 **Electrostatic voltmeter for ac or dc; it draws little current**

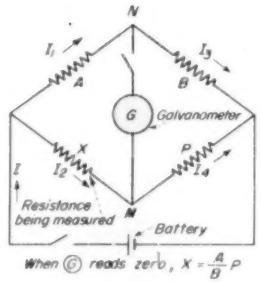
INSTRUMENTS FOR MEASURING RESISTANCE



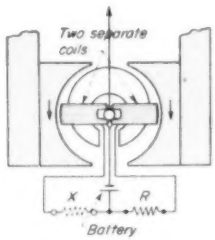
1 Resistance found with ammeter and voltmeter if dc available



3 Voltmeter and dc feed used to measure insulation resistance



2 Wheatstone bridge has a good accuracy down to about 0.1 ohm



4 Ohmmeter indicates ratio of X to standard R; scale in ohms

There are several ways to handle this job of resistance measurement. Probably the most obvious is an ammeter and voltmeter, Fig. 1. Values of volts and amperes are substituted in Ohms law formula and resistance determined by simple division. This is a good method to keep in mind. But since resistance measurement can be handled with one instrument, with good accuracy, keep the volt-amp idea as a spare rather than as plant practice.

The same holds true for measuring high resistance with a voltmeter alone, Fig. 3. Although insulation resistance measurements are often made with a voltmeter, there are inherent drawbacks. To make such a measurement with any degree of accuracy, you need a high-resistance (high ohms-per-volt) voltmeter. On top of that a source of dc is required.

Low Resistance. Kelvin and Thomson double-bridge are standard laboratory equipment for measuring low resistance. Getting into the power engineers' practical range we first meet the Wheatstone bridge, Fig. 2. Basically, this is a combination of known resistors, battery and galvanometer combined with the unknown resistance. Bridge is balanced when galvanometer, connected across opposite midpoints of bridge, reads zero. Value of the unknown resistance is determined by substituting in formula under Fig. 2.

One typical, practical, low-resistance-measuring instrument is shown in Fig. 11. This handles from 1 millionth of an ohm up to 1 ohm without any special skill of the operator.

A logical question at this point is, "Where in the plant are low-resistance measurements taken?" Typical jobs are measuring resistance of cable joints and connections, oil circuit-breaker contacts, troubleshooting on transformer windings and other coils.

Up to now we've considered low-resistance measurements, in the range from a few ohms down. But probably most routine resistance-measuring jobs around the plant are from a few ohms up. And here's where ohmmeter and megohmmeter come into the picture.

In essence, a typical ohmmeter has a permanent-magnet, moving-coil element, in series with a fixed and variable resistor and a battery. Two terminals on the instrument allow the external resistor being measured to connect in series with this circuit (see p 87). Moving element indicates value of current flowing through complete circuit. Instrument scale, however, is calibrated in ohms. This is possible as current flow is governed by ohmic value of resistor under test.

This same device is often adapted for voltage and current measurements by an internal combination of shunts and resistors.

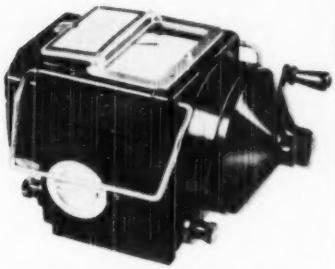
INSULATION RESISTANCE

Electrical insulation is the "wrapper" around all electrical conductors. Its job is to limit electric-current flow from conductor to ground, or an adjacent conductor. We use the word *limit* since no insulation is perfect; a small leakage current is always present.

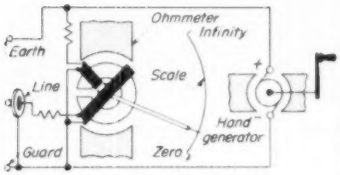
Insulation resistance of electrical equipment varies with age, voltage, moisture content, and other physical factors. It is important that we have some way of indicating its effectiveness and the most practical is to measure resistance of the insulation itself.

One good way to measure this value of insulation resistance is with a megohmmeter. Many different-type megohmmeters are shown on facing page. You can summarize their operating principles in a few words. First, these instruments have

...AND MEGOHMMETER: ALL HANDLE RESISTANCE MEASUREMENTS

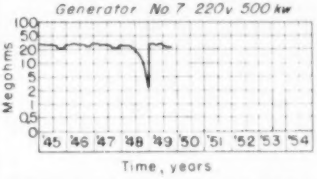


5 This megohmmeter develops its voltage with a hand-cranked generator

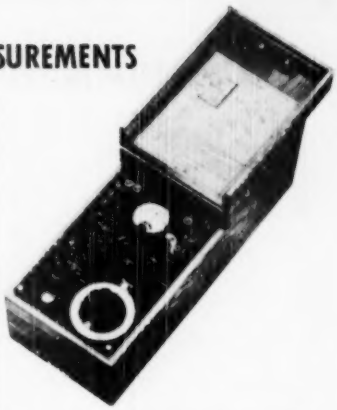


6 Internal wiring of unit in Fig. 5. Clutch rig assures constant voltage

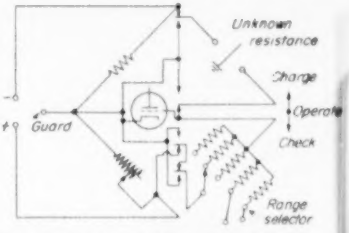
7 Battery-fed vibrator-transformer is source for the 500-v test potential



8 Keep individual record of insulation resistance for electrical equipment



9 Bridge-type megohmmeter operates from 115-v with transformer-rectifier



10 Wheatstone bridge circuit for unit in Fig. 9 uses vacuum-tube detector

some means for developing a test voltage (hand-cranked generator, rectifier, battery, for example). Current flow through insulation under test is then measured. The scale is marked off in terms of ohms or megohms, eliminating any need for mental gymnastics.

In using any of these instruments keep a few fundamental thoughts in mind. First, voltage rating of the megohmmeter for testing new apparatus should not exceed voltage prescribed in AIEE standards. So in testing new insulation don't let ac test voltage exceed twice named voltage of machine, plus a thousand. In other words, do not use a 2500-v megohmmeter on any equipment rated less than 750 v.

Further, for apparatus in service several years, megohmmeter voltage is much lower. This is only common sense, to avoid unnecessary breakdown. Actually, megohmmeter voltage does not have to be as high as rated voltage of the apparatus being tested.

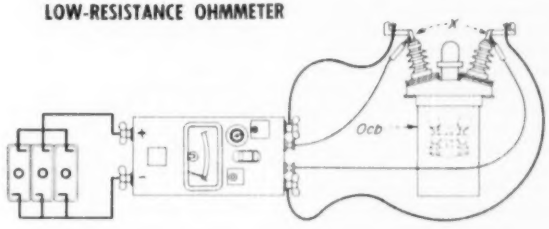
It is well to develop the habit of periodically measuring insulation resistance. Then go a step farther and keep a record of those values. Typical card in Fig. 8 shows one good way to keep track of them.

When testing with a megohmmeter, make sure the circuit you are working on is "dead."

When it comes to minimum values of insulation resistance it is difficult to establish a hard-and-fast rule. Nevertheless, the old rule of "one megohm per thousand volts" still holds true. And that boils down to a rule-of-thumb value of one megohm for most equipment in smaller plants where voltage range is below 1000. For similar equipment in the 2000-v range, two megohms is a reasonable minimum.

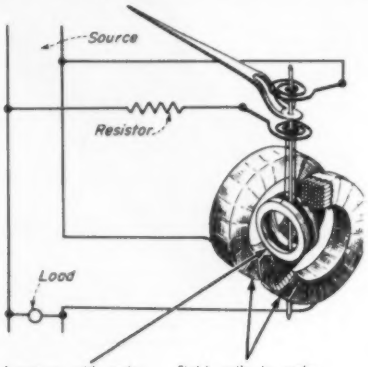
But once you start establishing set rules for minimum value of insulation resistance, you find them difficult to live up to at times. So one practical gage to spot bad insulation is the *trend* in insulation resistance as time progresses. Here's the real value of keeping a record of insulation resistance for each piece of equipment. At a glance you see how the insulation-resistance curve varies over the months. Any marked downward trend indicates trouble is starting.

LOW-RESISTANCE OHMMETER



11 This direct-reading instrument is designed for low-resistance measurements—down to one microhm (one millionth of an ohm)

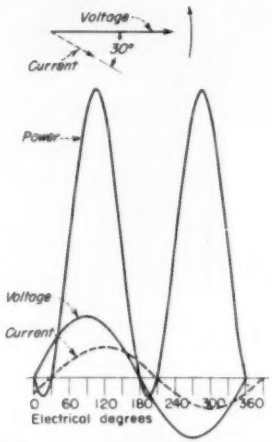
DYNAMOMETER INSTRUMENT MEASURES POWER



Armature, with series resistor, taps across line; its flux is proportional to voltage

Field coils in series with line. Their flux is proportional to the current flowing

1 **Instrument's torque is proportional to the instantaneous product of E and I**



2 **Dynamometer-type wattmeter considers the phase difference between E and I**

POWER . . . MEASURED BY WATTMETER

Any operating lad can measure voltage and current. It's simply a matter of hooking the voltmeter across the line and the ammeter in series with the line. But measurement of power may prove more difficult unless the fundamentals are clearly understood.

In two short pages we are going to discuss wattmeters and their applications. Fundamentally, the wattmeter measures the power being consumed in an electrical circuit. That's fairly simple with dc. For ac, we need to know a little more about what goes on.

Where your load is all resistance, as with infrared drying lamps, the circuit current is in phase with the voltage. We then have unity power factor. Instantaneous value of power, or watts, is the product of the instantaneous current and instantaneous voltage. Although both current and voltage are negative during one half of each cycle, their product is always positive. This can be explained by recalling from your algebra days that product of two negative quantities is positive.

Unfortunately, all industrial loads are not pure resistance. For instance, a motor has coils that are embedded in iron or steel, thus introducing inductive reactance into the circuit. Current required to magnetize this iron will lag the impressed voltage by 90 deg. The greater this magnetizing current, the farther away from the *in-phase* position will be resultant current, Fig. 2. If we reached the theoretical case where total current flowing was 90 deg out of phase with the voltage, there would be no power or watts consumed. We can see that the mere product of voltage and current is not, in a reactive circuit, a measure of the power being used.

WATTMETER PRINCIPLE

Dynamometer instrument, discussed on page 77, is the generally accepted measuring device. Measurement of power by this instrument is possible because torque in the moving element is proportional to product of instrument's field and armature currents. Field coil connects in series with the line, and armature or moving element connects through a resistor, across the line.

Field flux is proportional to line current while armature flux is proportional to line voltage.

It follows that the instantaneous torque or twisting power of the armature is proportional to the instantaneous product of line current and voltage. Since inertia of the moving system prevents pointer following instantaneous power values, the resultant or average power is indicated on the instrument's scale.

In the curve in Fig. 2, notice that the product of current and voltage is sometimes positive and at other times negative. Hence the power indicated is partly positive and partly negative. Wattmeter averages the resulting positive and negative torques, averaging the power above and below the zero axis.

Varmeter. Besides being used to measure watts, the dynamometer element has wide application in measuring reactive volt-amperes or *vars*. Remember, the wattmeter indicates product of circuit voltage and component of current in phase with the voltage. Varmeter indicates product of voltage and component of current, 90 deg out of phase with voltage.

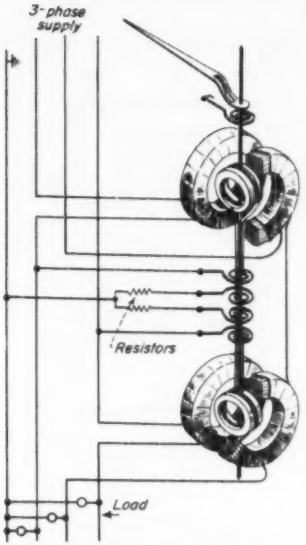
This is done, in single phase, by shifting the phase of the voltage across instrument's potential coil, Fig. 8. Hence potential-coil flux is in phase with flux produced by reactive component of current in field coil.

It is not at all uncommon to find vars, which do no useful work, equal to the watts. That's one cause for overloaded feeders. Many industrial plants are recognizing the value of installing capacitors or synchronous motors to supply the magnetizing vars.

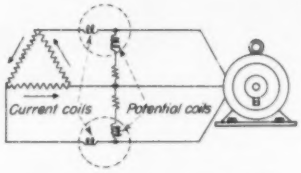
Ratings. Wattmeters are rated not only in watts, full-scale deflection, but also in amperes and volts. Ampere ratings indicate the maximum current to be passed through the field coil. On the other hand, voltage ratings show range of potential circuit voltages that instrument is designed for.

Hence a wattmeter having a 5-amp current rating will have a full-scale rating of 250 watts at 50-v; 500 watts at 100-v; 1000 watts at 200-v. Now we're getting to the meat. If a 200-v instrument is operated at 50 v, you will get a reading of only 250 watts with the maximum rated current of 5 amp flowing. And leading on from there we can see that to reach a full-scale reading of 1000 watts we need 20 amp. You can see how the instrument might be overloaded even though its deflection did not exceed full scale.

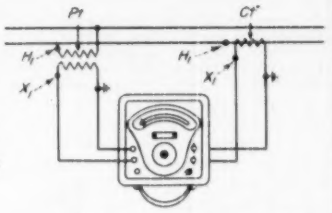
A similar condition arises when measuring power in a circuit where the pf is low. For instance, if a single-phase load is pulling 8 amp



3 Two-element wattmeter modified for use on four-wire, three-phase circuit

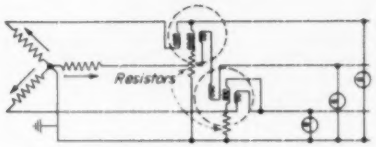


4 Two-element wattmeter measuring a three-wire, three-phase load



5 Typical wattmeter connections with instrument transformers

PUTTING WATTMETER TO WORK AROUND THE PLANT



6 Connections for wattmeter shown in Fig. 3. Use three single-phase meters for maximum accuracy

at 200 v and 0.6 pf, the wattmeter reads 960 watts. This is 40 watts short of the scale maximum. But, in the meantime, 160% of rated current is flowing through the instrument. Moral is: Consider voltage and current maximum ratings of the instrument being used. Then don't forget pf of load. One way to get around this is to use an ammeter in the circuit, Fig. 7.

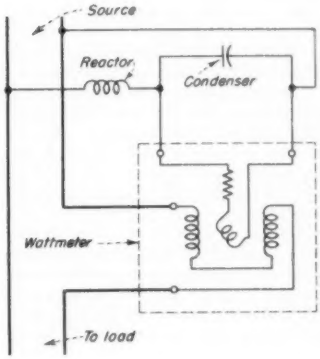
Power measurements involving high current are made in conjunction with a current transformer. In those cases, wattmeter current rating is usually 5 amp. Current transformer used must have a current-ratio such that at full load its secondary current is within ampere rating of wattmeter.

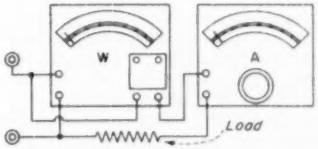
Likewise, for potentials up to 750 v, series resistors are used in the armature circuit of many wattmeters. When you meet higher voltages, a potential transformer is used.

A word of caution: When a wattmeter is used with a current or potential transformer, or both, include all multiplying factors. For instance, if the current-transformer ratio is 5:1 and the potential-transformer ratio is 4:1, the multiplying factor is 20. In other words, if the wattmeter reads 10 watts on its scale, it should be multiplied by 20. The actual power being consumed by load would be 200 watts.

If you have struggled through this special section up to now, you are probably wondering just where you would use a portable wattmeter in a typical industrial plant. That's a fair enough question. One good application is in checking actual load on an electric motor.

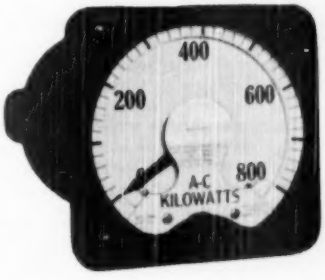
While we're speaking of motors, if the wattmeter is used in conjunction with a voltmeter and an ammeter, it is a simple matter to determine power factor of the load. All you do is divide wattmeter reading by product of voltage and current (in the case of a single-phase load). That gives you the power factor. Another use for a portable wattmeter is in making a load survey. So if you want to determine how much power is being consumed throughout the plant, and where, a wattmeter is the instrument to use.





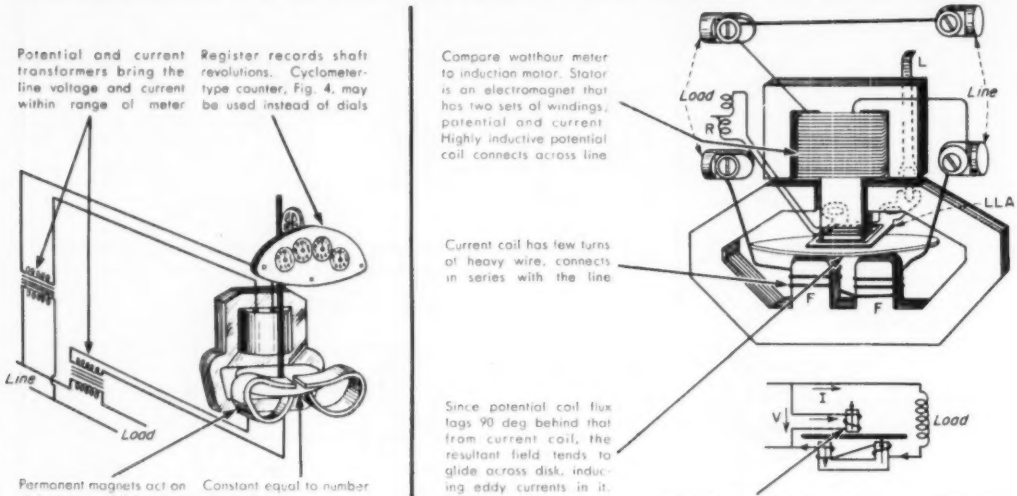
7 Ammeter in series with the wattmeter current coils checks on overloading

8 Measuring reactive volt-amperes with a converted dynamometer wattmeter



9 Typical concentric-scale wattmeter for single-phase power measurements

OPERATION AND HOOKUP OF TYPICAL SINGLE-PHASE WATTHOUR METER...


Potential and current transformers bring the line voltage and current within range of meter
Register records shaft revolutions. Cyclometer-type counter, Fig. 4, may be used instead of dials
Compare watthour meter to induction motor. Stator is an electromagnet that has two sets of windings, potential and current. Highly inductive potential coil connects across line
Current coil has few turns of heavy wire, connects in series with the line
Since potential coil flux lags 90 deg behind that from current coil, the resultant field tends to glide across disk, inducing eddy currents in it. These eddy currents react with the gliding field, and by Lenz's law, disk will tend to follow field
Permanent magnets act on disk to establish shaft speed for a given load. Disk speed in turn determines watthour constant.
Constant equal to number of watthours corresponding to each revolution of disk. Magnet position is varied for calibration
Note that potential coil connects in on line side of current coil. Hence its current will not actuate meter. Torque produced is proportional to product of line voltage and the in-phase current
Line
Load
L
R
F
I
V

1 **Watthour meter may be connected directly in circuit if voltage and current are low**

2 **Here's a rear view of watthour meter and streamlined explanation as to how it operates. Line connects to the two terminals on upper right**

ENERGY... MEASURED BY WATTHOUR METER

Before digging into this matter of watthour meters, let's review two common terms: *power* and *energy*. The average lad in the plant uses them loosely, but there is quite a difference in their real meaning.

Definitions. In the past two pages we spoke about wattmeters. They deal with the basic unit of measurement for electrical power, the *watt*. Electrical power is the *rate* at which electrical energy is used. And its unit of measurement, the watt, implies a time factor. Hence the term watt includes the implied meaning "per hour."

When we think of watthour meters, we are dealing with electrical *energy*. We can define that as total use of electricity over a period of time. It is the product of rate of use (power or watts) multiplied by the number of time units, usually in hours.

With these definitions off our chest, let's get down to the business of watthour meters – what makes them tick and how they are used. Basically, the watthour meter is a small motor whose instantaneous speed is proportional to the power passing through it. On top of that, total number of revolutions of this motor in a given time is proportional to the total energy or watthours drawn during that time. For dc, this motor is an adaptation of the familiar shunt motor. Armature with a compensating field winding goes across the line. Main field windings connect in series with the load. And that's all we're going to say about the dc watthour meter.

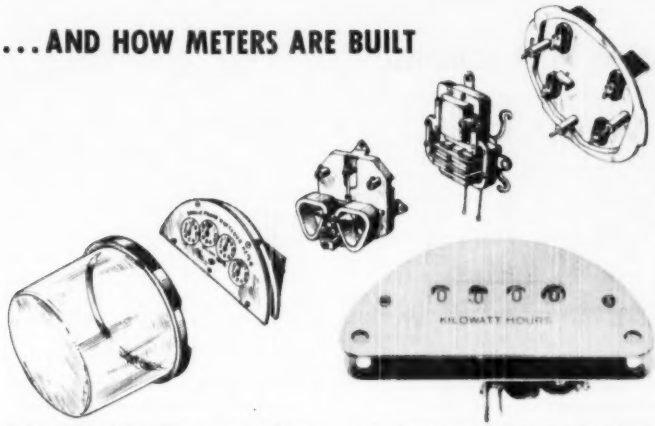
The ac induction watthour meter's action may be likened to that of the typical induction motor. And once again, the turning of this motor is proportional to the power in the metered circuit. In addition to the motor, a watthour meter has a magnetic braking system and a register.

Motor. The rotor you see whipping around in your watthour meter is an aluminum disk. And the worm gear that drives the register is generally cut directly in the shaft connected to this rotor. Bearings may be jewel and pivot type or ball-bearing type. Then, again, the rotor may be magnetically suspended. In this case guide pins maintain vertical alignment of the shaft. At any rate, the moving system is mounted so the aluminum disk is centered in the air gap of the laminated assembly, Fig. 2.

Stator for the little motor is an electromagnet which has two sets of windings. Each is assembled on a laminated, soft-iron case. One winding, called the potential coil, is connected across the metered circuit. Our other winding – the current coil – connects in series with the load.

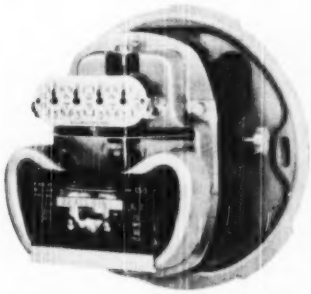
Potential coil is made up of fine wire and so has high resistance. Actually, it places a negligible load on the circuit. But the current coil is different. That's made up of relatively few turns of heavy wire. And,

...AND HOW METERS ARE BUILT

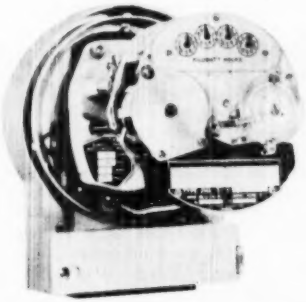


3 Exploded view shows cover, register, permanent magnets, coils and frame

4 Cyclometer registers are often interchangeable with pointer-dial type



5 Polyphase meter in single-phase case. Two disks are mounted on single shaft



6 Single-phase meter with time-switch automatically controls offpeak loads

in turn, its resistance is mighty low.

Why It Turns. After reading the following sentences let your eyes skim over Fig. 2. First, let's consider the magnetic flux produced by the current coil. That passes through the aluminum disk, hence induces eddy currents in it. Now let's go back a bit to our basic theory. First, when a conductor in a magnetic field carries current, it tends to move. This results from the interaction of the field around the conductor and the main field that the conductor is in. Let's see how this applies.

As we explained above, eddy currents are induced within the disk by the current coil. These in turn produce their own magnetic field. And it is this magnetic field that interacts with the field from the potential coil, causing motion of the disk.

Drag Magnet. Now that we've got the disk in motion, let's say a few words about keeping its speed within a reasonable, usable range. First off, the watthour meter disk would tend to race if there wasn't some way of damping, or loading it.

Permanent magnets shown near front of Fig. 5 do this job, acting as a magnetic brake. They are mounted so the disk rides between their poles. And, as the disk rotates, it cuts field from the braking magnet. Once again a voltage is induced in the disk. This voltage, in turn, produces eddy currents. And it's these currents that react with the permanent-magnet flux to produce a damping torque. This torque is in opposition to the motor torque. The effect of this brake can be varied by adjusting permanent-magnet position.

Polyphase Meters. In the little discussion above we confined our thinking to the single-phase meter. Where we have more than one phase (polyphase), a series of single-phase meters can handle the job. Total load on the polyphase system will then be the algebraic sum of the registrations on the meters. This won't be too practical, hence the polyphase meter.

In a nutshell, this is made up of two (or three) elements with disks on a single shaft and contained in one case. And in this polyphase meter the algebraic addition of registrations mentioned above is performed mechanically. So the total driving torque of this combination is the sum of the torques of the individual members. Therefore, it is proportional, at any instant, to the power in the circuit.

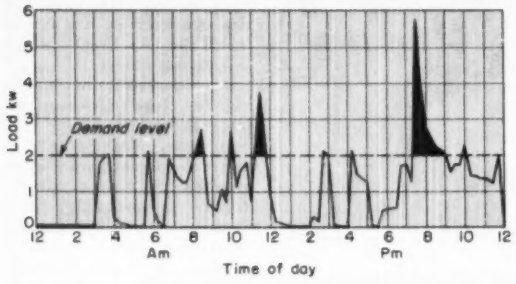
Calibrating. And now for a thumbnail sketch on calibration and adjustment. You have often seen the test boys run a check every so often on the watthour meters in your plant. What they do is use a standard indicating wattmeter to measure the average power over a stated period. And, at the same time, the revolutions of the disk in the watthour meter are counted with the aid of a stop watch.

They then check the average meter watts by taking the meter constant K, and multiply it by the number of revolutions of the disk. This quantity is then multiplied by 3600, the job is finished by dividing that product by the time in seconds, ticked off on the stop watch. The value of watts you get after you have gone through those mental gymnastics is compared with the watts read on the standard wattmeter used. That watthour meter constant, K, mentioned above is the number of watthours represented by a single revolution of the aluminum disk.

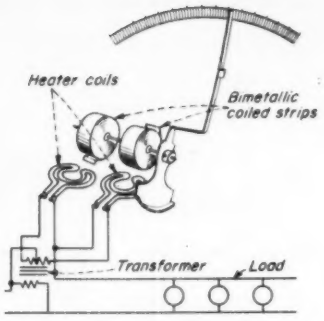
Meter is adjusted to read properly at full load and unity pf simply by varying the position of retarding magnets. It is adjusted at light load by the light-load adjustment lever shown as L in Fig. 2. Jiggling the lever L moves the single-turn coil right below the potential lug; it is marked *LLA*. Shifting this off-center makes the main coil above it "shaded," just like the shaded pole in a small single-phase motor. By adjusting this loop properly the friction within the meter can be compensated for. Hence, the disk will begin to move just as soon as a very small load is applied.

Just a few words now about another adjustment, namely, *lag* adjustment. That means adjusting the watthour meter so flux from the potential coil lags 90 deg behind the voltage applied to the load. This is done by adjusting the value of resistance R, shown in Fig. 2.

DEMAND CHARGE STEMS FROM PEAK LOADING



1 Since generating and distribution equipment must be ready to handle peak loads, a demand charge goes along with the kwhr or *running* costs to compensate for *fixed* costs involved



2 Operating principle of thermal-type demand meter shown. The load current supplies heat to operate bimetal coils

DEMAND METERING AND WHY IT'S IMPORTANT TO THE POWER ENGINEER

This business of supplying electrical energy is somewhat peculiar because, broadly speaking, the product to be sold cannot be stored. It must be used as generated and the supply source must stand ready to furnish its product at any hour. The demand for this product varies quite a bit, as shown in Fig. 1. And yet it is necessary to install and have available generating equipment to carry the peak of the load safely.

Why Demand? All this means that machinery, representing a good-sized investment, must stand idle a large part of the time. This peculiarity of the business has led utility companies to divide into two parts the cost of supplying their customers. First, *fixed costs* that are somewhat independent of the amount of electricity delivered to the customer. On top of that, *running costs* that depend directly on the amount of energy delivered.

In a typical utility, fixed costs are large because of the great amount of time during which a portion of the equipment on the distribution system stands idle. Hence the establishment of a demand charge so the total service rendered bears some relation to the total cost of rendering it. Investment necessary – so a utility may stand ready to supply any group of customers – depends on the maximum demands consumers make for electricity. And in many plants that purchase energy, maximum-demand indicators are used in conjunction with watthour meters. They proportion the fixed costs among the customers.

Figuring Demand. Demand indicators record the greatest *sustained* amount of current, power or kilovolt-amperes that are used. They are not supposed to indicate demands of such short duration that no serious burden is placed on the generating equipment. Length of time during which demand must be sustained varies with the individual case. Common time intervals are 15- 30- and 60-minute intervals. Demand, which is expressed as an average, might be determined by inspecting a chart from a recording meter, and then integrating (summing up) selected portions of the record for the required time interval. Because this procedure is laborious, typical meters were developed such as those in the last column of the following page.

To set up a really crackajack rate schedule, a demand meter should give not only the power demand, but the hour in which it occurs. In that way, if you take a large demand at a time when generating equipment and a distribution system would otherwise be idle your charge will be relatively low. This is common sense since it necessitates no additional investment on the part of the supplier. But the fellow who pays the higher rate is the lad who takes the same demand at the time of peak load.

Actually, though, it is only for large consumers that a utility feels justified in installing this form of demand meter. And by that is meant a demand meter that shows the time at which the maximum demand is imposed, as well as its size.

Now here's the story with the small consumer. An allowance is made for the fact that not all demands occur at the same time by swinging in a *diversity factor* when the rates are originally set up. And we can define this as the ratio of the maximum power demand of a certain section to the maximum demand of the whole system.

A demand meter may be looked on as a means for inducing a higher plant *load factor* or longer steady operating hours. This may ease the mental blow somewhat when the demand is considered solely as a penalty for high peaks in conjunction with low kilowatt-hour consumption. The meter itself can be used to your advantage in the plant by using its indication as a guide when peak-load periods come up.

Temperature is the principal limiting factor in determining the amount of load that can be imposed

on electrical equipment. The limiting temperature on insulating material is reached only if an overload is sustained for an appreciable period of time. That's the reason demand is averaged over a definite period of time.

Meter Types. Eliminating the recording wattmeter from the demand picture, there remain two basic-type meters in use. They are known as *integrated-demand* (block-interval) and *lagged-demand* meters.

Probably the best way to look at the integrated-demand meter is to consider it equivalent to a fast-stepping meter reader who reads the watthour meter every 15 or 30 minutes. Instruments in this classification are usually connected with a watthour meter. In that way the energy consumed is measured and registered periodically. Then the maximum demand can be determined from the record. The actual connection with the watthour meter may be either by gearing or by electrical impulses. Where it's a matter of electrical impulses, they are sent out from contacts that are made when the watthour meter has swung around a given number of revolutions.

In the block-interval type, a record is made of the energy consumed during the block period. These readings may be registered on a tape or recorded on a chart. The important thing is that the time is shown at which the maximum demand occurred.

Still others in this same grouping have an indicating pointer that is carried upward over a graduated scale. It moves upward as the watthour meter rotates. The pointer is left at this maximum position when, at the end of the time interval, the registering mechanism is momentarily thrown out of gear and returned to the zero position. In some of these meters a spring-driven clock is used to operate the resetting mechanism. In others, a small synchronous motor does the trick.

Lagged-demand meters bring the question of time lag into the picture. They require a definite time interval for the indication to reach the point corresponding to the value of the load. The main idea here is to make the indicator lag behind the actual value of the load – just about the same way that rising temperature in the supply equipment lags behind the load taken from it. This principle is brought out nicely up in Fig. 2.

TERMS USED IN DEMAND METERING

LOAD FACTOR. Ratio of the average power of any particular plant to the maximum power over a certain period of time. Average power is taken for a day, a month or a year. Maximum is taken as the average over a short interval of the maximum load within that period.

DEMAND. Load averaged over a specified period of time. Demand is expressed in kilowatts, kilovolt-amperes or amperes.

MAXIMUM DEMAND. Greatest of all demands that have occurred during the given period. The various meters for measuring maximum demand are described above.

DEMAND INTERVAL. Period of time for which demand is measured. It may be 15, 30 or 60 minutes.

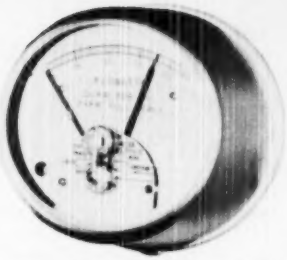
DIVERSITY FACTOR. Ratio of sum of maximum power demands in a particular section of a system to maximum demands of whole system.

AVERAGED MAXIMUM DEMAND. Highest average or arithmetical mean of several similar demands. It may be computed from several demands on a definite number of days. These days may be either consecutive or within certain time limits, such as months or a year.

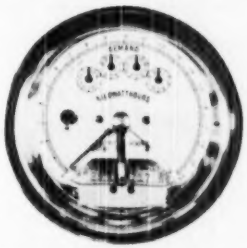
DEMAND METER. Device to indicate or record the demand or the maximum demand.

INTEGRATED-DEMAND METER. Meter to indicate or record maximum demand obtained through integration (summing up).

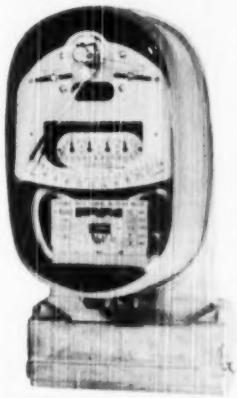
LAGGED-DEMAND METER. Where maximum demand indication is subject to a characteristic time lag.



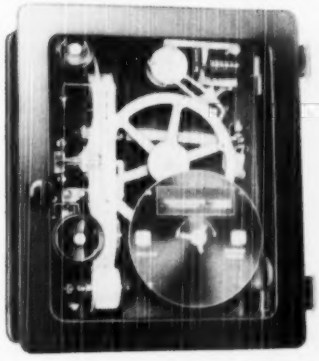
3 Demand meter, shown schematically in Fig. 2, made in single and polyphase models. Type shown for socket mounting



4 Single-phase block-interval watthour demand meter integrates and averages the demand over definite time interval



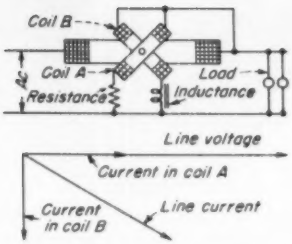
5 Combination polyphase watthour and demand meter. Pointer movement along lower scale is function of demand load



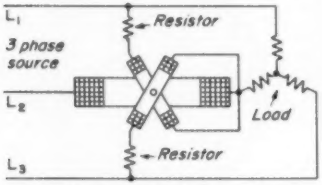
6 Printing type records demand for each demand interval. Maximum demand then found by removing and reading tape

Pf = Watts / E x I

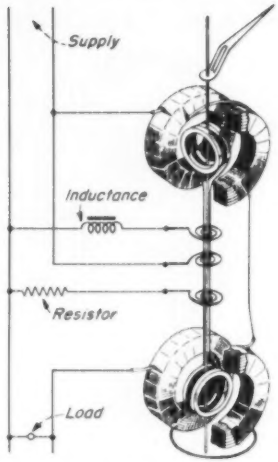
POWER FACTOR RATIO OF WATTS TO VOLT-AMPERES



1 Schematic and vector diagram for the crossed-coil, single-phase pf meter



2 Note how crossed-coils connect across opposite phases eliminating reactor



3 Two-element variation on the typical crossed-coil meter shown in Fig. 1

We are not going to start off power-factor measurement with a long drawn-out, complex dissertation on the why's and wherefore's of pf. (See p 90, March 1949, POWER). Instead, we'll sum up by saying the watts recorded on your wattmeter do the work that shows up on the motor's shaft end. Coming along for the ride, we have vars (reactive-volt-amperes). They are really a watt headed in the wrong direction. These vars come into the picture wherever inductive or capacitative equipment is involved.

Pf in a single-phase circuit is ratio of watts divided by volts times amps. If pf is unity, there are no vars. Then volts times amps equals watts.

Utility companies often have a clause in rate schedules that penalizes low pf. At low pf we have our friend vars putting an additional burden on the distribution system along with the generating equipment.

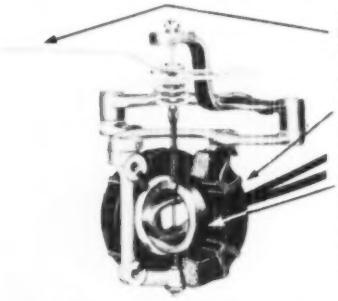
How Pf Is Measured. Pf meters, in addition to various forms of synchroscopes, stem direct from the fundamental Tuma meter, Fig. 1.

A simple pf instrument somewhat resembles the single-phase wattmeter. It has a stationary-field coil mounted on a frame; coil carries the line current. It differs from the wattmeter in that it has no control spring and has two armature coils. These are mounted on the same shaft in such a way that their axes are about 90 deg apart. One of the moving coils connects across the line through a noninductive resistor. So its flux reacts with that of the field coils to produce a torque proportional to the in-phase or working component of line current.

Now notice how the other moving coil connects across the line to an inductive reactor. Recalling our fundamental rules for ac, we see that current in this coil lags practically 90 deg behind its voltage. In that way, torque developed by this coil is proportional to the line-current component that is 90 deg out of phase with the voltage.

How Instrument Works. Now here's how the turning torque is produced. When instrument is connected in a unity pf circuit, line current is in phase with voltage. So current in the armature coil (coil *A*) rises and falls like a sine wave, together with voltage. Therefore full torque is developed in coil *A*. At the same time, since we have no out-of-step current, no torque is developed in coil *B*. Moving system then swings into a position so there is maximum flux alignment between field (current) coil and armature coil *A*.

It is but a short step from here to understanding how the instrument works at a pf other than unity. If the load were a pure reactance, line current lagging or leading by a full 90 degrees, *B* would be the coil to produce the torque. It would align itself with the main field flux in a way similar to coil *A* in the unity pf case. Instrument scale would then be calibrated to read zero pf, lag or lead. Now you see that any position the pointer takes between these two extremes is a compromise in torques developed in both coils *A* and *B*.



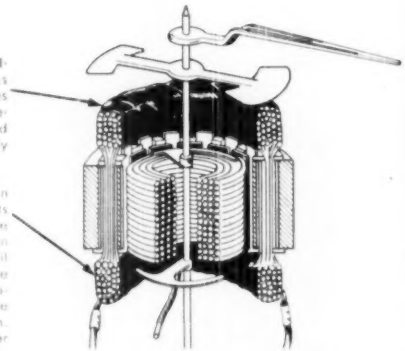
4 Polyphase pf meters read correctly only when the circuits are balanced

Scale is mounted below pointer and indicates both lag and lead pf

Crossed-coil type has one fixed coil through which line amps flow, and two moving coils mounted on same shaft. One moving coil goes across line through a resistor, while other is in series with a reactor. For single- and 2-phase service, construction is like mounting a wattmeter and varmeter on same shaft since torque is proportional to ratio of the watts and vars

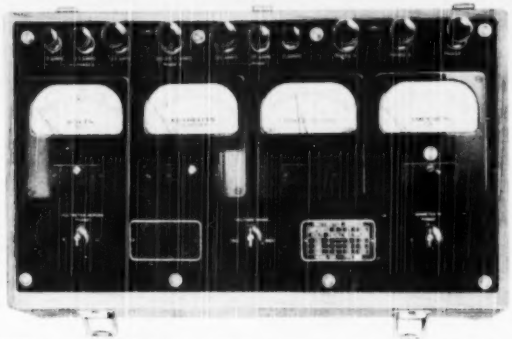
Motor-type field winding connects across the line and produces rotating field. Phase-splitting circuit is used on single-phase only

Current coil ties in series with line. Its job is to magnetize moving vanes. When current and field-coil flux are in step, vane polarity same as rotating field, and hence assumes set position. Any deviation, either lag or lead, shifts vanes and pointer to either side of unity pf

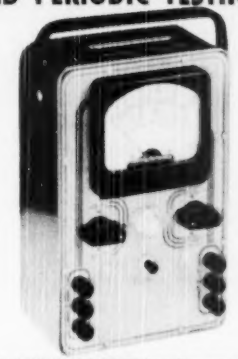


5 Polarized-vane pf meter, well suited for lines where current may reverse

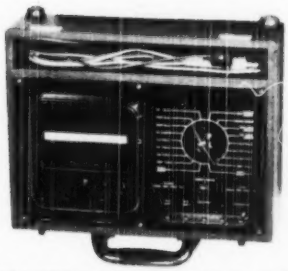
INSTRUMENTS THAT SIMPLIFY TROUBLE-SHOOTING AND PERIODIC TESTING



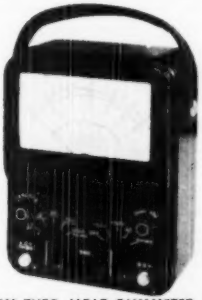
INDUSTRIAL ANALYZER is designed to measure current, voltage and power in single- and poly-phase circuits besides pf in 3-phase 3-wire circuits. Well suited for detecting underloaded or overloaded motors. Ammeter is equipped with adjustable pointer stop to measure maximum starting current



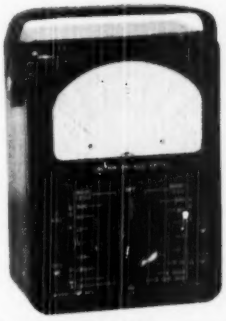
VOLT-AMP WATTMETER handles up to 100 watts. Ct is available to extend range to 500 and 10,000 watts; 65 and 130 amp. Designed for single-phase testing



VOLT-OHM MILLIAMMETER for ac or dc use. As selector switch on panel is moved to desired range, a mechanism rotates the proper range into view behind window



VACUUM-TUBE VOLT-OHMMETER can be used for circuit testing where it's necessary to keep current drain to a minimum. Ohmmeter range includes up to 1000 megohms



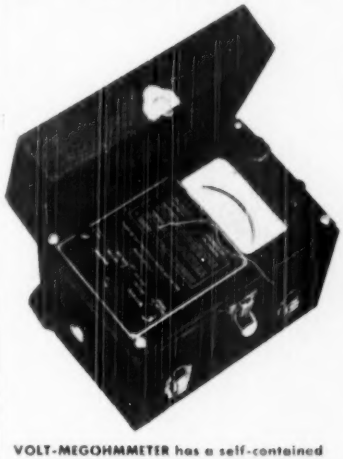
VOLT-OHM MILLIAMMETER measures to 6000-v ac or dc with selector switch picking out one of six ranges. In four scale steps it will handle up to 100 megohms

SPLIT-CORE VOLT-AMMETER combines 2 ac voltage ranges and 4 ac current ranges in one instrument. Change from amperes to volts made with one selector switch

INSTRUMENT COMBINATIONS

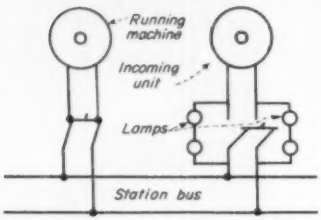
If several portable instruments are in frequent use around the plant, it's a distinct advantage to have them grouped, where possible, in a single case. Typical is the combination of clamp-on ammeter and voltmeter, shown to left. In a matter of minutes this one instrument takes both current and voltage readings.

Likewise, the load analyzer, top, is voltmeter, ammeter, pf and kilowatt meter – all in one case. Only a few simple connections are needed to place it in the circuit.

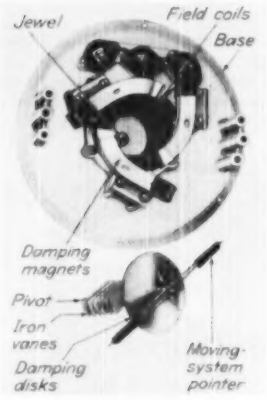


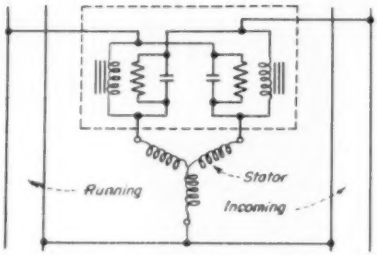
VOLT-MEGOHMMETER has a self-contained battery-vibrator mechanism for use when testing insulation. Measures to 600-v ac, 300-v dc. Ohmmeter range is 0 to 2000

LAMPS OR SYNCHROSCOPES TELL WHEN AC CIRCUITS CAN BE PARALLELED



1 **Machines may be paralleled by closing switch with synchronizing lamps dark**



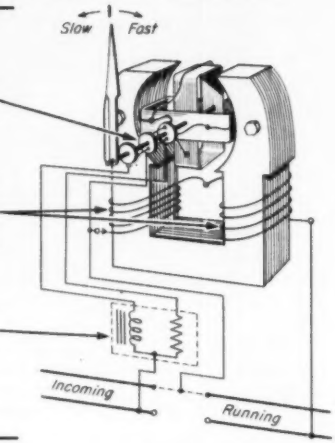


3 **Operation of the moving-iron synchroscope depends on alignment of iron vanes with resultant of two magnetic fields that are rotating in opposite directions**

Current is carried to moving coils by slip-rings and brushes so element is free to rotate. Armature coils mount on shaft, and are set nearly perpendicular to each other

Frame structure consists of laminated iron core with windings on each leg. Field coils top across bus while armature connects to incoming machine. When pf's are used, be mighty careful about their polarity markings

Impedor is usually mounted outside the instrument. It connects to sliprings so that one armature coil is in series with resistor and the other connects in series with a reactor



2 **Unlike the pf meter, crossed-coil synchroscope element is free to rotate**

SYNCHROSCOPE FOR PARALLEL AC OPERATION

Essential instruments in an ac power plant, having more than one generator, are voltmeter, ammeter and synchroscope. Voltmeter is used to hold voltage steady; ammeter checks current output to keep it within machine rating. Now let's look at the synchroscope.

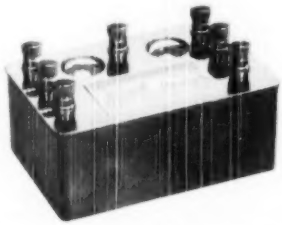
Synchroscope's Job. In paralleling two ac generators they must have equal voltages, frequencies that match, the same phase rotation and proper phase relationship. Phase rotation is set at time of installation. A voltmeter checks the voltages of bus and incoming machine. Frequency is a matter of speed adjustment. And the test of whether voltages are rising and falling in step may be made with a voltmeter, lamps or a synchroscope. The simple lamp or voltmeter method is shown in Fig. 1.

Synchroscope handles the job of synchronizing or paralleling to a finer degree than either lamps or voltmeter. Reason is that in conventional use of lamps or voltmeter, the *exact* point of synchronism cannot be determined. The synchroscope shows relative phase angle and frequency difference between the incoming machine and the bus. It indicates whether the incoming machine is running faster or slower than the one already on the line. When its pointer comes slowly to an upright position, both machine and bus are in phase. The slow and fast indication tells operator what adjustments to make to get machine voltage in step with bus.

Types. One of the commonest type synchroscopes is shown in Fig. 2. This instrument is, in principle, a Tuma phase-meter. However, there is a slight modification in that the currents are carried to crossed coils by brushes and slip-rings, or an equivalent arrangement, so moving element can rotate continuously.

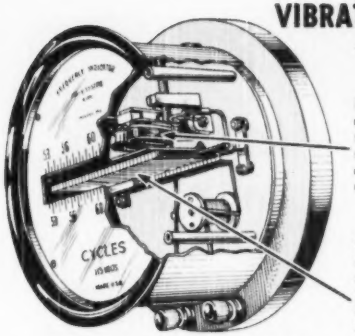
There are several variations of the iron-vane instrument. One type is shown in Fig. 3. The fundamental idea, however, is to avoid use of sliprings and brushes.

Operation of the iron-vane (sometimes called moving-iron) synchroscope depends on alignment of the iron vanes with the resultant of rotating magnetic fields. Under normal conditions, with voltages of both bus and incoming machine equal, rotating fields are of equal strength. It's the resultant field that may rotate in either direction, or stand still. This depends on the relative frequency and phase relationship in the two-phase shifting circuits. When the machine and bus are at same frequency and phase relationship, pointer is stationary and one end is at the index mark.



4 **Phase sequence in polyphase alternating-current circuits is determined by noting which of the two neon lamps glows**

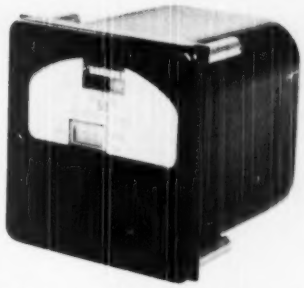
VIBRATING-REED AND RESONANT-CIRCUIT INSTRUMENTS



1 Cutaway of switchboard-type vibrating reed meter. Device maintains accuracy within ±20% of rated voltage

Frequency of supply circuit is transmitted to reeds by small electromagnet vibrator. When this frequency is within instrument's range, several reeds vibrate in resonance forming a visible pattern, Fig. 3. Coil and its series resistor tap across the line being checked

Steel reeds, mounted in brass reed shoes, have their tips bent and painted white for easy seeing. By selecting materials, dimensions and tip loading, each reed is tuned to a specific natural frequency. Reed comb is assembled from progressively tuned reeds. It is supported by two flat springs and is set in vibration by the coil's armature



2 This panelboard-type reed instrument has a time clock incorporated in face. Used to keep tally on operating hours

FREQUENCY

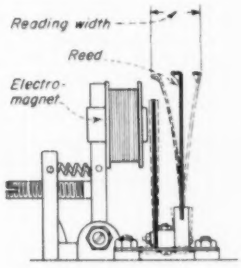
METERS INDICATE CYCLES PER SECOND

If we used electricity only for lighting, the problem of maintaining and indicating correct frequency would be of little concern. But when we consider equipment like motors and transformers, correct frequency is mighty important.

Frequency is measured in cycles per second. With minor exceptions, frequency universal in the U. S. today is 60 cycles per sec. Another way to say this is that current flows in one direction, stops, reverses itself and flows in opposite direction – one complete cycle – 60 times per sec.

Resonant Circuit. A dash of theory is in order. In a simple electrical circuit containing only resistance, current is right in step or phase with voltage. If we slip a coil (inductance) in series with our resistor, current lags behind the impressed voltage.

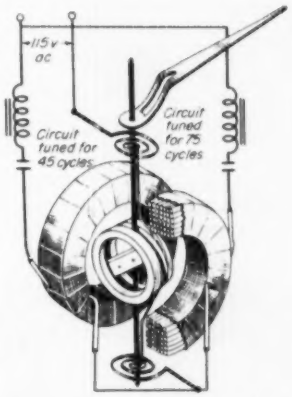
When both coil and condenser are placed in this circuit, in series with the resistor, whether resulting current leads or lags voltage depends on the values of inductance and capacitance. Now here's our point: By juggling size of both coil and condenser – so reactance of all is equal – they will, in effect cancel each other out. Now the resistor alone determines value of current flowing and circuit is said to be in *resonance*. This is the underlying idea behind the instrument in Fig. 4.



3 Heart of instrument shown in Fig. 1. Screw at left allows adjustment of the reed pattern till it fills scale opening

Note how one circuit on this instrument, Fig. 4, is tuned or adjusted for resonance at 45 cycles. That means the value of inductance and capacitance in that circuit was picked so effect of both coil and condenser cancels out at 45 cycles. So at this frequency maximum current flows. You can apply this same reasoning to the second circuit that's adjusted for resonance at 75 cycles.

Since we are dealing with frequency in the 60-cycle range, current through both these circuits is always out of step with voltage. These two out-of-phase currents join hands at the common junction after leaving field coils, and march together through the armature coil. Now remember that torque is proportional to product of armature flux and the in-phase component of field flux. So whether the armature favors moving in the direction of one field coil or the other depends on the value of current in the respective field coils.

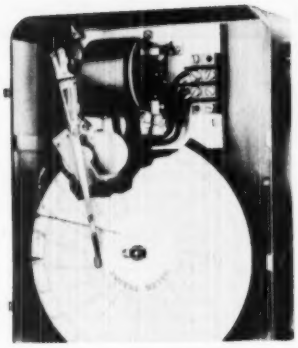


4 Resonant-circuit instrument uses the frequency-versus-reactance characteristics to provide the deflecting torque

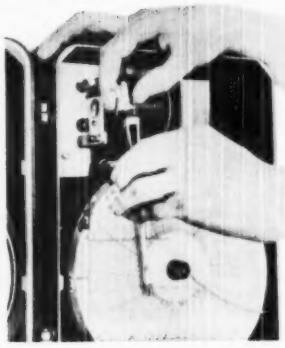
Resonant Reed. A reed vibrates vigorously when hit with rhythmic impulses at a rate equal or nearly equal to its natural frequency. Comparing the reed to an army crossing a bridge, the soldiers break step to avoid setting up resonant vibration that could damage the bridge.

Essential part of a reed-frequency instrument, Fig. 1, is a set of consecutively tuned reeds. Supply-circuit frequency is transmitted to these reeds by a small electromagnetic vibrator. When frequency of vibrations set up is within instrument's range, several reeds vibrate, forming a visible pattern, Fig. 3. A reed in resonance may be compared to a lad swinging a whip. While he moves the handle only slightly, the tip will swing through a wide arc. This is similar to the reed pattern.

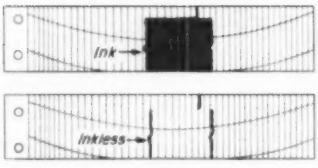
PUTTING RECORDING INSTRUMENTS TO WORK



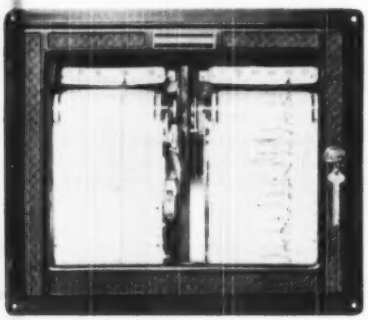
1 Recording ammeter with chart cut away to show measuring element and damper



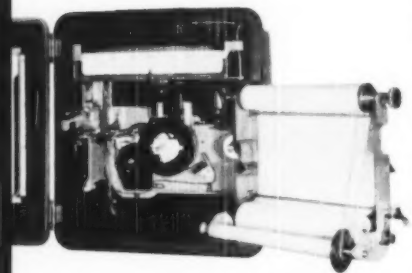
2 Removable pen arm is pivoted at top. Gravity controls pressure on chart



3 Comparison of ink and inkless record for a continually varying voltage



4 One clock may be used to drive both charts in this twin-type instrument



5 Ready for chart replacement. Entire unit also accessible for inspection

If we were to take any of the instruments discussed up to this point, equip their pointers with pen and paper, you'd have a crude recording device. To make it practical, a paper-moving mechanism must be included. Then by marking off paper or chart in regular time intervals, and adjusting chart-moving rig accordingly, you are all set to put it to work in the plant. That's the basic idea behind the typical recording instruments shown on this page.

Where to Use. Graphic or recording instruments used around the plant get permanent information that comes in mighty handy in improving general operation. The power engineer finds good use for recorders, both portable and switchboard, in keeping track of total load and in checking faulty equipment conditions.

Let's consider a few specific uses in an average plant. Take a portable recording wattmeter, hooked in on the feed to a motor of a machine that's acting up. We know an electric motor increases power consumption in almost direct proportion to the work it does. Hence by measuring the power flow to the motor we learn if it is overloaded, or if driven machine binds occasionally, throwing extra load on motor.

One advantage of a permanent record of total power consumption is a check on demand measurements. It gives prompt information on any increase or reduction in peak loads. Often pyramiding of peak loads can be traced to unnecessary simultaneous starting of equipment. Likewise, poor scheduling of equipment that's used intermittently. One example is an electric oven. A little forethought, and its working cycle can often be shifted to off-peak periods.

Voltage. It's mighty important that plant-supply voltage be kept reasonably constant. Starting torque of induction motors drops off about as the square of the voltage reduction. A motor that's carrying full load at proper voltage quickly overheats if voltage is lowered appreciably.

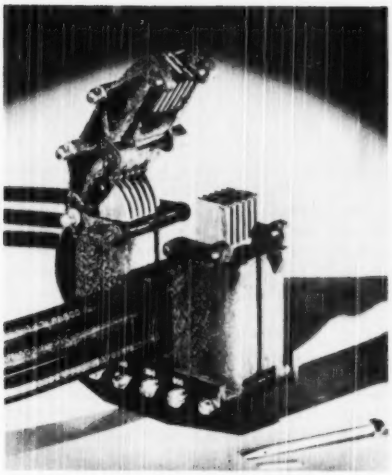
Now let's look at the lighting picture. Economy and life of lamps means holding a constant voltage of proper value. If plant voltage is above lamps' rating, life is cut way down. On the other hand, drop circuit potential below lamps' voltage rating, and light output is lowered considerably.

Portable recording voltage instrument may be swung into action for checking the duty cycle on an elevator or any motor-driven machine that's operated intermittently. By simply hooking it across the motor's terminals, and setting chart for time and date, a running record is made of number of times motor started and how long it kept running.

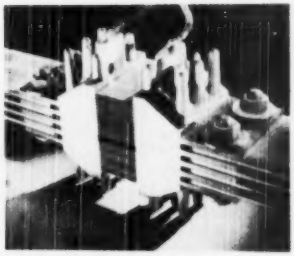
Recording Unit. Both inking and inkless methods of making the recording are available. In the inking setup on one manufacturer's instrument, a capillary tube carries ink from a stationary inkwell up through the pointer to the writing tip. Rear end of pen is fitted with a counterweight to permit adjusting for the right touch of pen on paper.

Inkless recorders use some typewriter principles to get the record on the strip chart. Series of dots are produced, close enough to form a continuous line except when the measured quantity fluctuates violently over a wide range.

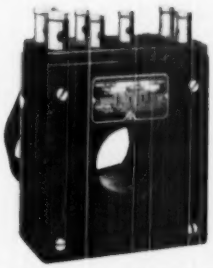
SHUNTS AND CURRENT TRANSFORMERS ARE USED FOR HEAVY-CURRENT MEASUREMENTS



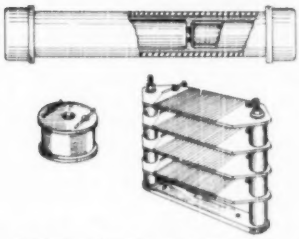
1 Hinged-top on this ct simplifies inserting and removing the primary cable. Top held in by pin



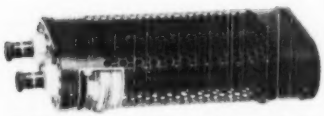
2 Shunt's center portion is usually manganin. This material is stable over a wide temperature range. The instrument connects across voltage terminals, close to resistance strips



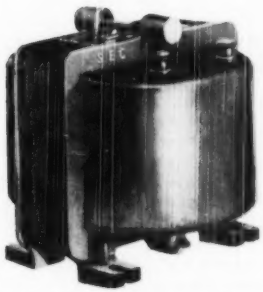
3 Portable current transformer is suitable for ammeter and wattmeter measurements. The ct range is varied by slipping two or more turns through center



4 Typical voltmeter resistors. Unit at top is designed for high-voltage use



5 Voltmeter resistor, called multiplier when it's external to the instrument



6 Potential transformers step-down the primary voltage to instrument range

ACCESSORIES THAT EXTEND THE RANGE

Instruments and meters do not in themselves cover all common measuring jobs in the plant. There must be some method to extend the range to include measurement of currents, voltages, watts, etc, beyond instrument's maximum rating. In brief, this means use of shunts and resistors for dc instruments, and resistors, current and potential transformers for ac.

Direct Current. To measure currents greater than maximum rating of moving-coil instrument (about 50 milliamperes) a shunt, Fig. 2, must divert major portion of current from moving coil. A shunt is merely a low resistance, usually of manganin strips, brazed to comparatively heavy copper blocks.

Used with a shunt, the ammeter is in reality a millivoltmeter since it measures voltage drop across the shunt. In the lower-current ranges shunts are usually put within the instrument case. On larger ranges, where the shunt is physically large, and heat generated in it is more than a few watts, external shunts do the trick. They're usually adjusted to give a voltage drop of 50 mv when shunt carries full load current.

Series resistor to extend a voltmeter's range has various physical shapes depending on application. Self-contained ranges use small, compact spools for more-sensitive instruments, and larger card resistors for those requiring more current, Fig. 4. And as with shunts, where heat released by the resistor is more than the case can radiate, the resistor is external, Fig. 5.

Alternating Current. Current and potential transformers extend the ranges of ac instruments as do shunts and resistors for dc. Besides permitting measurement of large currents and voltages, instrument transformers effectively insulate the instrument from the line.

Potential transformers, Fig. 6, are usually dry-design below 5000 v and oil filled above that voltage. Secondary sides are generally wound for 110 v and rated between 40 and 200 watts.

Current transformer's primary usually has a few turns wound on a core, connected in series with the line. When designed for portable-instrument use, provision is made to put the primary through the iron core, Fig. 1 and 3. Ct secondaries are usually rated at 5 amp. A word of caution: Never open-circuit a ct's secondary while primary is carrying current because a very high voltage will build up across the open secondary winding.

SELECTION OF INSTRUMENTS AND PRECAUTIONS WHILE USING

Perhaps the most important single characteristic to take into account, when selecting an electrical instrument or meter, is the kind of current it will be used with – alternating or direct. For dc, it usually means selecting the permanent-magnet, moving-coil instrument for voltage and current measurements. At the expense of fine accuracy, one of the moving-iron instruments may be used. And for most wattage checks on dc circuits the dc ammeter and voltmeter will do the job. Unlike the ac case, their product is always equal to the power being drawn.

For measurement of alternating voltage and current the dynamometer movement is by far the most accurate. But in most routine testing and trouble-shooting, one of the moving-iron instruments will do the trick nicely and at reduced first cost. Probably the one most useful instrument for everyday work is the split-core volt-ammeter. This device measures volts and amperes without opening the circuit.

Range. After the basic type instrument is decided on, your next consideration is the proper full-scale range for the electrical quantity to be measured. If the approximate size of the quantity is known, it's a simple matter to select an instrument so the reading will be well up on the scale. Incidentally, you'll generally find the point of best accuracy is about two-thirds of full scale. Keep that in mind when selecting scale range.

If an unknown voltage is to be measured, use common sense and a high-reading voltmeter. If all you get is a wiggle above the zero position, switch over to a lower range (on a multirange instrument) or another instrument to fit the job at hand. Using a high-range first will often save damaging an instrument.

Probably more important than selecting correct range for a voltmeter is range selection for an ammeter. You can readily see this since once a voltmeter is in the circuit there is generally little variation. But the current picture is quite different in a typical plant. After the ammeter is hooked in, starting up another machine may throw the pointer off scale with possible damage to the instrument. So make sure range is adequate.

Accuracy. Most portable instruments are accurate within a fraction of 1% of full-scale value. Yet that high degree of accuracy may be canceled, and then some, if a few common-sense rules regarding use are not followed. First rule is shielding against outside magnetic fields. And the most practical shield from your point of view is air. If an instrument is to be located on a panel, consider the distance between instrument and conductors carrying heavy currents.

If the basic instrument accuracy is to be maintained, keep unshielded permanent-magnetic instruments 5 to 8 in. apart on centers. This will cut down interaction between fields of both instruments. These figures apply specifically to unshielded 3-in. panel instruments. High-grade portable instruments having built-in magnetic shields can touch each other without loss in accuracy.

Sizable errors in reading, say, up to 5%, creep in by placing permanent-magnet instruments, having a wooden or plastic case, directly on a sheet-iron floor or bench. Flux leakage from the permanent-magnet tends toward a higher reading. Such errors may be avoided by placing the instruments on a box or other support 4 to 5 in. high.

And temperature can change accuracy. Most instrument manufacturers guarantee their instruments to be within normal accuracy for a temperature change of ± 10 C. The normally accepted ambient is 25 C or 77 F.

Scale Divisions. A practical thought at this point is the way an instrument's scale is divided. Scale divisions are classified as main, intermediate and subdivisions. Main divisions are generally set off so that they'll break up the scale at easily read points, or so one of them is at a frequent reading-point on the instrument.

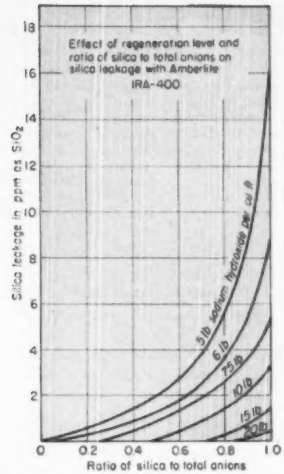
This is particularly important in multirange instruments since a scale may read like a charm at one range and be difficult as all get-out on another. Check this point next time you're picking out an instrument. Remember that easily read scales cut down the possibility of error while reading instrument.

Polarity. Reversing leads on a permanent-magnet instrument results in pointer swinging the other way and banging against the backstop. This isn't the case with moving-iron devices since direction of current flow doesn't influence pointer to any great degree. We're hedging a little at this point since it's necessary to take two readings on dc with moving-iron instrument – second reading with leads reversed. The average then gives a more accurate reading.

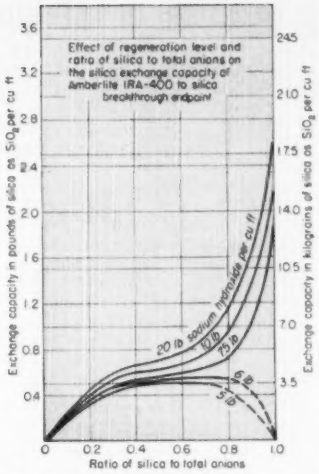
But reversing terminals is of no consequence for ac ammeters and voltmeters. That's what happens twice each cycle anyway. But the story is somewhat different when speaking of ac wattmeters. Most of these fellows have some marking notation, usually plus and minus marks – one on the current terminal, the other on the potential. To get an up-scale reading, the instantaneous current in both current and potential circuits must enter these marked posts at the same polarity. In other words, hook both terminals with polarity markings on the same side (or phase) of the main line.

ACKNOWLEDGMENTS

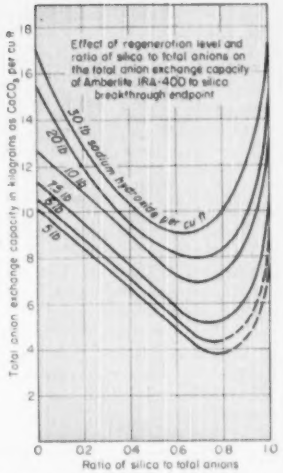
During preparation of this special section, liberal use was made of technical data supplied by electrical instrument and meter manufacturers. POWER is indebted to the following concerns for their fine cooperation: James G Biddle Co, The Bristol Co, Burlington Instrument Co, The Electro-Mechanical Instrument Co, The Esterline-Angus Co, Inc, General Electric Co, General Radio Co, The Hickok Electrical Instrument Co, International Instruments Inc, Leeds & Northrup Co, Roller-Smith, Sangamo Electric Co, Sensitive Research Instrument Corp, Sheffield Instrument Corp, Simpson Electric Co, Herman H Sticht Co, The Triplett Electrical Instrument Co, Westinghouse Electric Corp, Weston Electrical Instrument Corp.


Effect of regeneration level and ratio of silica to total anions on silica leakage with Amberlite IRA-400
Silica leakage in ppm as SiO_2
Ratio of silica to total anions
3 lb sodium hydroxide per cu ft
6 lb
7.5 lb
10 lb
15 lb
20 lb

1 Leakage depends on regeneration level and the silica to total-anion ratio


Effect of regeneration level and ratio of silica to total anions on the silica exchange capacity of Amberlite IRA-400 to silica breakthrough endpoint
Exchange capacity in pounds of silica as SiO_2 per cu ft
Exchange capacity in kilograms of silica as SiO_2 per cu ft
Ratio of silica to total anions
20 lb sodium hydroxide per cu ft
10 lb
7.5 lb
6 lb
5 lb
3 lb

2 Relation between capacity, silica to total-anion ratio and regeneration


Effect of regeneration level and ratio of silica to total anions on the total anion exchange capacity of Amberlite IRA-400 to silica breakthrough endpoint
Total anion exchange capacity in kilograms as $CaCO_3$ per cu ft
Ratio of silica to total anions
30 lb sodium hydroxide per cu ft
20 lb
10 lb
7.5 lb
6 lb
5 lb

3 Total anion-exchange capacity based on the silica breakthrough endpoint

Silica Removal by Ion Exchange

By JOSEPH THOMPSON & FRANCIS X McGARVEY
Rohm & Haas Co, Resinous Products Division

Deionization produces the equivalent of distilled water in ionic purity, and now offers a safe, practical, low-cost way to remove dissolved silica by direct ion adsorption

► MODERN HIGH-PRESSURE BOILERS demand water of reduced solids, controlled alkalinity, zero hardness and extremely low silica. Since deionization is a low-cost way to produce ionically pure water, why has it not been adopted previously as the ideal treatment for boiler feedwater?

Answer is that until recently no practical means of silica removal in conjunction with deionization had been developed. Now there is a change in the situation, brought about by the introduction of a strongly basic anion-exchange resin that removes silica as an economical, practical part of the deionization process.

Turbine Scale. Vaporization of silica (Reference 1 and 2 on p 95) and its resulting mixing with the steam presented a different approach to the underlying cause of turbine-blade scaling. This extremely hard and adherent scale was previously thought to be introduced mechanically only in carryover with the steam. In recent years turbine-blade deposits and boiler-tube scale of the sodium-alumino-silicate type have presented some of the most difficult problems to the water-conditioning engineer.

Effect of scale on turbine capacity and efficiency has been described by Soderberg (Ref 3) and Buckland (4). Burkordt and Imhoff (5) have shown from X-ray diffraction studies of turbine deposits that the scale consists of several forms of silica, but no direct relationship exists between operating conditions and type of silica deposited.

To alleviate the possibility of silica-scale deposition, it is common practice in high-pressure boiler plants to control amount of blowdown on the basis of silica concentration rather than on total solids. Straub reported that turbine-blade scaling can be avoided if the silica concentration, in a boiler operating at about 1250 psi, is kept below 10 ppm. Ebert and Thompson (6) established the following maximum silica concentration consistent with troublefree operation for the boiler pressures studied in several plants:

Boiler press., psig	*Silica, ppm (max)*
200	100
400	65
600	45
900	30
1200-1500	5-10

It was claimed that no scale deposited in boiler tubes or on turbine blades when silica concentrations were held within the above limits in numerous plants included in the survey.

Early Studies. Initial recognition of the problem prompted intensive research on methods by which silica could be removed from water before it entered the boiler. Early studies of the silica content of natural waters and methods for its reduction may be found in publications by O M Smith (7, 8, 9), who studied the coagulation of silicic acid by means of alkaline earth hydroxides like lime. Rosenheim (10) used the acidic gels of titanium, tin, tungsten, thorium and molybdenum as well as the hydroxides of copper, zinc, cadmium, iron, tellurium, aluminum, manganese and magnesium.

Process studies on the use of aluminum hydroxide have been reported

TABLE I—SUMMARY OF CALCULATIONS ON REGENERATION CHEMICAL COSTS

Type of water	Method of treatment	IR-105 lb of 66° Be H_2SO_4 per kgr cation as $CaCO_3$ removed	IR-105 cost of acid/1000 gal of water treated, ¢	IR-4B lb of NaOH per kgr mineral acids as $CaCO_3$ removed	IR-4B cost of NaOH per 1000 gal of water treated, ¢	Ratio silica to total anions as $CaCO_3$	IRA-400 total anion capacity kgr as $CaCO_3$ per cu ft	IRA-400 lb of NaOH per kgr total anions as $CaCO_3$ removed	IRA-400 average leakage, SiO_2, ppm	IRA-400 cost of NaOH per 1000 gal water treated, ¢	IRA-400 cost per ppm SiO_2 removed per 1000 gal treated, ¢	Total cost of deionization plus SiO_2 removal treatment per 1000 gal, ¢	Total cost of treatment if IR-4B is regen with waste NaOH from IRA-400, ¢
I	A	0.33	4.25	—	—	0.046	9.6	0.522	0.2	20.0	1.66	24.25	—
I	B	0.33	4.25	—	—	0.058	9.5	0.527	0.2	16.0	1.33	20.25	—
I	C	0.33	4.25	0.12	2.94	0.12	9.0	0.555	0.3	8.1	0.68	15.29	12.35
I	D	0.33	4.25	0.12	2.94	0.264	8.4	0.715	0.5	4.75	0.40	11.94	9.0
II	A	0.33	0.92	—	—	0.07	9.5	0.525	0.2	4.64	1.11	5.56	—
II	B	0.33	0.92	—	—	0.07	9.5	0.525	0.2	4.64	1.11	5.56	—
II	C	0.33	0.92	0.12	0.61	0.132	8.9	0.562	0.4	2.6	0.62	4.13	3.52
II	D	0.33	0.92	0.12	0.61	0.132	8.9	0.562	0.4	2.6	0.62	4.13	3.52
III	A	0.29	5.15	—	—	0.06	9.5	0.527	0.2	29.7	1.25	34.85	—
III	B	0.29	5.15	—	—	0.155	8.8	0.568	0.5	12.4	0.54	17.55	—
III	C	0.29	5.15	0.12	1.73	0.078	9.4	0.53	0.2	22.8	0.99	29.68	27.95
III	D	0.29	5.15	0.12	1.73	0.41	7.6	0.988	0.5	8.15	0.35	15.03	13.3

by Lindsay and Ryznar (11) and Behrman and Gustafson (12). Betz, Noll and Maguire (13, 14) reported the use of magnesium salts in the form of the sulphate, the relatively pure oxide, or the oxide as found in combination with calcium in dolomitic lime, to reduce successfully the silica content of feedwater to about 1 ppm in the hot lime-soda softener, or phosphate precipitation-type softener, or both.

Modifications, involving the recirculation of precipitated sludge from the settling cone to top of tank, or sludge-blanket filtration, or combinations of both, have resulted in much more effective use of the reagents introduced for silica adsorption. Moreover, cold-process precipitation methods involving the use of ferric salts have resulted in the reduction of silica to slightly less than 3 ppm in some instances.

New Demands. Although these methods produce water of controlled alkalinity, and lower hardness, silica and total-solids content, satisfactory for some boiler plants, the trend toward higher operating pressures and higher percentages of makeup water demands consideration of processes that give greater reduction of silica and total dissolved solids.

The only means of producing this high-quality water, heretofore, was by evaporation. For this method Applebaum (15) reported single-effect evaporation as costing $2 to $8 per 1000 gal whereas the costs may be reduced to 60¢ to $1 per 1000 gal by employing multiple-effect evaporators. Using waste steam, of course, greatly lowers these costs.

According to Latham (16), a compression still is equivalent to a 15-effect evaporator and produces a water of excellent quality for 50¢ to $1 per 1000 gal depending on the use of diesel fuel or electricity for driving the compressor. Finally, Kominek (17) compared the economics of the various ion-exchange and evaporation methods.

In an effort to adapt the deionization process, with resins heretofore available, to produce water free of silica as well as electrolytes, the fluosilicic-acid method has received widespread attention. Normally, the first step in deionization involves a strong acid-type cation-exchange resin operating in the hydrogen cycle, in which soluble salts are converted to their respective acids.

The acidic effluent then passes through a second container employing a weak base-type anion-exchange resin that removes the acids. As the process generally includes some means for carbon-dioxide reduction, the finished water is essentially free of all dissolved solids except silica. Silicic acid is a very weak acid so most anion-exchange resins cannot adsorb it.

Fluosilicic acid, on the other hand, has the properties of a strong acid, a fact utilized by Lourier and Klyachko (18), and Bauman, Eichhorn and Wirth (19). They found that introducing hydrofluoric acid into the effluent from a cation exchanger resulted in the formation of fluosilicic acid, which could be eliminated subsequently by a weak-base anion exchange resin. Their further investigation led to refinements involving the use of sodium and calcium fluoride as the sources of hydrofluoric acid. They recorded treatment costs of 0.5¢ to 0.7¢ per 1000 gal of water per ppm silica removed by this method.

These figures were confirmed by Jukkola and Thompson (20), who reported costs of 8.0¢ to 8.554¢ per 1000 gal of water containing 10-ppm silica. This process has several disadvantages. It requires (1) complex equipment (2) careful control for successful operation, and (3) a safe method for disposing of waste regenerant contaminated with fluorides.

Direct Silica Removal. A more desirable method of silica reduction in conjunction with deionization employs a direct-anion-exchange resin sufficiently basic to permit removal of the weak silicic acid. The use of such a material has been reported by Calise and Lane (21). They indicate that capacities of 2 to 6 kilograins of silica as calcium carbonate per cu ft were realized with regeneration levels of 3 to 6 lb of NaOH per cu ft of resin. They point out that capacities vary with detention time, silica concentration, carbon-dioxide concentration and possibly other factors for the anion exchanger of medium basicity investigated.

Optimum conditions for silica removal by direct ion exchange now can be provided by recently developed strongly basic anion-exchange resins. One form, Amberlite IRA-400, is so strongly basic it can be likened to solid caustic with only its hydroxyl ions in solution. It is capable of completely splitting neutral salts, and exhibits unusual capacity for weakly acidic substances such as phenols, carbon dioxide, hydrogen sulphide, boric acid and silica (22).

Because of these desirable properties, an extensive investigation was under-

taken to determine the applicability of IRA-400 to the removal of silica from water supplies. The data obtained have been correlated to enable the prediction of silica capacity and leakage values over a wide range of conditions.

Following points of particular interest were developed:

1. The resin's capacity for silica can be considered as independent of influent silica concentration over the range studied (up to 500 ppm SiO_2).

2. At flow rates as high as 5 gal per cu ft per min, no reduction in exchange capacity or increase in silica leakage is observed.

3. Silica is apparently removed as $(Si_2O_6)^=$ with an equivalent weight of 60, rather than 30, as generally considered to be the case in water-conditioning practice.

4. Use of $NaHCO_3$, NH_4OH and Na_2CO_3 are ineffective as compared to NaOH for the resin's regeneration in the silica-removal process.

5. Its exchange capacity for silica and the extent of silica leakage to the treated water depends on the ratio of silica (as $CaCO_3$) to total anion content (as $CaCO_3$) of the water treated, as well as the regeneration level.

Capacity of IRA-400 for silica removal may be best expressed graphically: Fig. 1 outlines the silica leakage to be expected as a function of regeneration level and silica-to-total-anion ratio. Fig. 2 shows the relationship between silica capacity, silica-to-total-anion ratio and regeneration level. Fig. 3 expresses the same data in terms of capacity for total anions (including silica and carbon dioxide) present. These capacity values are based on silica breakthrough as the cycle endpoint.

With the aid of these data it is possible to estimate the silica removal capacity of IRA-400 under almost any set of conditions normally occurring in natural waters, as follows:

1(a) Assume water containing the following constituents:

Silica, as SiO_2	6 ppm or 5 ppm as $CaCO_3$
Carbon dioxide, as CO_2	10 ppm or 23 ppm as $CaCO_3$
Sulphates, chlorides and nitrates	5 ppm as $CaCO_3$
Total anion content	33 ppm as $CaCO_3$

1(b) Assume average silica content of treated water shall not exceed 0.2 ppm SiO_2:

$$(2)\quad \frac{\text{Silica as } CaCO_3}{\text{Total anions as } CaCO_3} = \frac{5}{33} = 0.152$$

(3) Refer to Fig. 1: Regeneration level of 6 lb NaOH per cu ft is required for average residual SiO_2 content of 0.2 ppm at ratio of 0.152.

(4) Refer to Fig. 2: Silica-exchange capacity = 0.26 lb as SiO_2 per cu ft, or about 1.75 kgrs as SiO_2 per cu ft of IRA-400.

(5) Refer to Fig. 3: Total anion-exchange capacity = 9.3 krs as $CaCO_3$ per cu ft.

Possible Combinations. There are several methods by which anion-exchange resins may be applied to the removal of silica in conjunction with deionization. Water may be passed in series through any of the following combinations of units, utilizing a sulphonic-acid-type cation exchanger operating in the hydrogen cycle, a weak-base anion exchanger in the free-base form, a degasifier, and a highly-basic anion exchanger.

Method A: Sulphonic-acid type to highly-basic anion exchanger. In this system, generally considered for waters low in bicarbonates, chlorides and sulphates, the cations are converted to their respective acids by the former, and all anions including CO_2 and silica are removed in the last step.

Method B: Sulphonic-acid type to degasifier to highly-basic anion exchanger. This method should be considered where water is *high* in bicarbonates and *low* in chlorides and sulphates. It provides for removal of carbon dioxide by degasification, with only silica to be removed by the strong-base-anion exchanger.

Method C: Sulphonic-acid type to weak-base-anion unit to highly-basic anion resin. For waters of *high* chloride and sulphate, but *low* bicarbonate content, second step removes strong mineral acids and the latter unit eliminates carbon dioxide as well as silica.

Method D: Sulphonic-acid to weak-base anion, to degasifier and then through highly-basic anion resin. When large quantities of all anions are present in a water, this system is generally found to condition the supply most economically. Here, hydrogen is substituted for the cations in the first step, the mineral acids produced are adsorbed in second step, carbon dioxide is reduced in the degasifier and, finally, silica is removed in the last unit.

It is apparent from the above that selecting the proper system to use for deionization with silica removal depends largely on the type of water to be treated, although initial equipment cost, operating attention required, space limitations, etc, must also be considered. Accordingly, chemical treatment costs

(*Continued on page* 170)

TABLE II — TYPICAL WATER ANALYSIS EXPRESSED IN PPM

Component	*Type I*	*Type II*	*Type III*
Total dissolved solids	266	63	324
Silica as SiO_2	12	4.2	23
Iron as Fe	0.01	0.7	—
Calcium as Ca	43	9.8	35
Magnesium as Mg	15	3.4	25
Sodium as Na	16	3.1	36
Potassium as K	2.6	1.2	
Bicarbonate as HCO_3	82.8	22	270
Sulphate as SO_4	105	21	63
Chloride as Cl	17	4.0	12
Nitrate as NO_3	7.7	2.0	—
Total Hardness as $CaCO_3$	169	38	190

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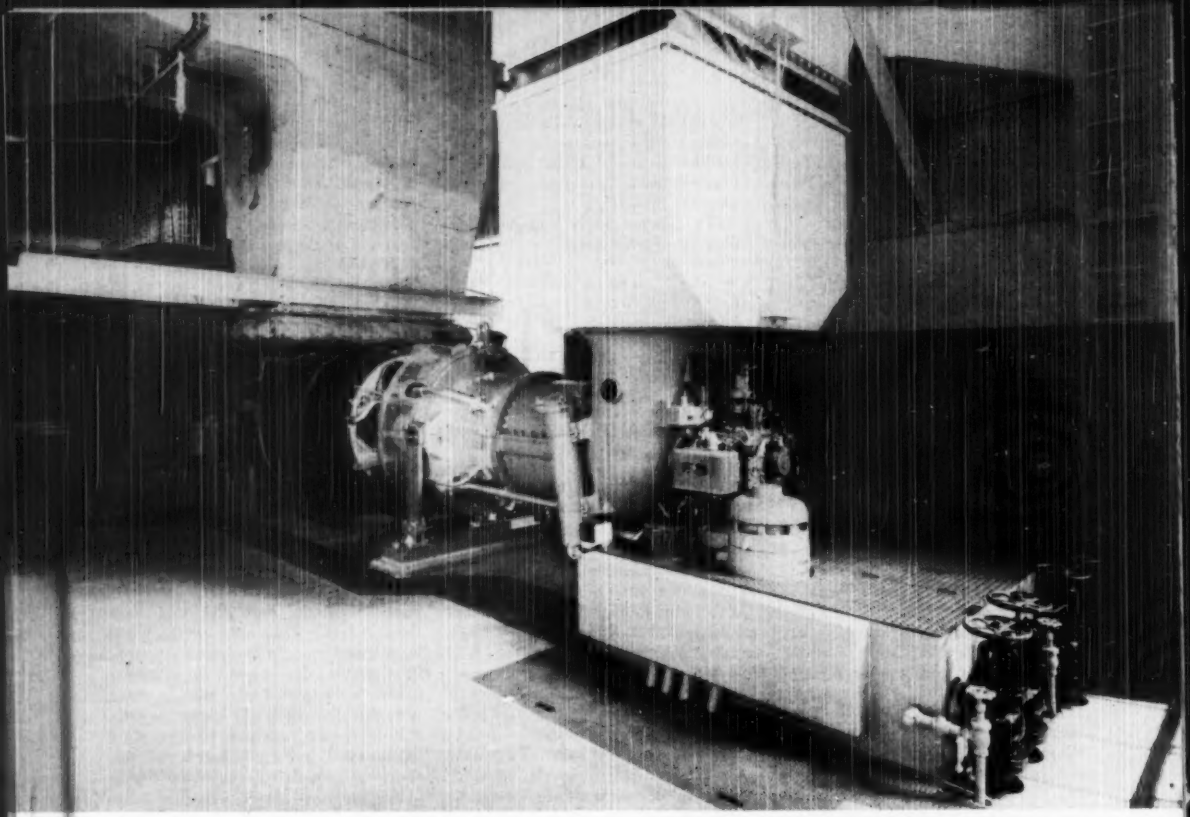


1 3500-kw gas turbine in operation at Arthur S Huey Station of Oklahoma Gas and Electric Co. Left to right: generator, reducing gear, turbine in dark casing, combustors behind the screen, compressor, air inlet, auxiliaries, oil pumps, tank

HUEY Gas Turbine Ticks Off 3400 Hours

Here are the facts on initial operation of first gas turbine to go to work in a utility system in U. S. The installation proves it to be most economical of alternative capacity extensions. Troublefree operation forecasts low over-all maintenance cost

By J W BLAKE
Assistant Supt of Generation
Oklahoma Gas and Electric Co
and R W TUMY
District Engineer
General Electric Co

► A LANDMARK in the progress of power generation was reached when the Arthur S Huey Station of the Oklahoma Gas and Electric Co installed its gas turbine. Besides being the first commercial gas turbine in the U.S. it has unusual features, which the authors detailed in an article in POWER (Sept 1948, pp 64-71) They are: (1) design to run on natural-gas fuel (2) recovery of exhaust heat in a recuperator for boiler feedwater heating (3) precooling of compressor-inlet air to raise unit capability during high summer temperatures. The installation moved along practically unchanged from original plans because of capable design by Pioneer Service & Engineering Co, Chicago, and efficient work of the OG&E Construction Department.

INSTALLATION

Excavation for the gas-turbine building started on Jan 15, 1949. Extended wet weather hampered the work, but April 15 saw the turbine foundation completed. About this time the gas-turbine unit arrived by rail from the General Electric Co. Building foundations and steel work were completed by May 5. Building siding and window sash were installed by May 20. By June 1 glazing and roofing were done and turbine installation was in progress. By this time the stack, duct, electrical work and the recuperator were well along. A final hydrostatic acceptance test was made on the Combustion Engineering-Superheater Corp recuperator about

July 1. All outside ductwork for recuperator and precooler was finished by July 15.

On July 29 at 2:15 pm the unit was phased to the system and ran for three hours without mishap. From breaking ground to going into service took 6½ months. Fig. 1 to 4 show various views of the installation. Turbine unit, panelboard and wainscot are painted aquamarine color. Walls and ceiling are jonquil yellow. Most of the installation cost figures are completed. Table I shows the approximate results.

GAS-TURBINE ERECTION

Since the unit had to be fitted in with an existing station, the time taken was longer than would be needed for a straight gas-turbine plant. Putting the generator stator and gear in place initiated erection of the unit during the latter part of May. Generator with its top-mounted air cooler is the same as is used with steam-turbine drive. Hence, this part presented no new problems. Reduction gear between generator and turbine shafts needed only the usual installation techniques.

Gas-turbine and compressor installation started on July 1. It was completed and running on July 28. The unit fired on the first start and operated satisfactorily. Load was not applied till July 29, since many checks and tests were made, including several trial starts.

Based on this experience, it appears reasonable to expect the complete unit to be installed within one month after receipt of the first part. This assumes that suitable foundations and crane-handling facilities are available.

STEAM-TURBINE COMPARISON

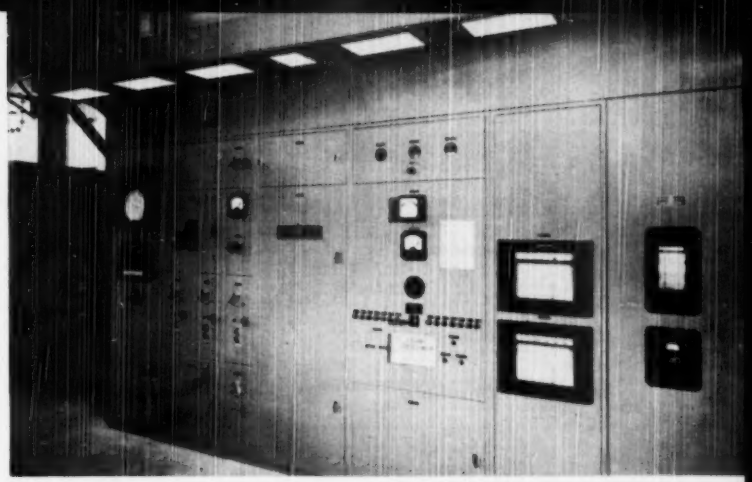
It is simpler to install a gas turbine than a steam turbine. One of the primary factors is the weight to be handled. These weights compare as follows:

	Gas turbine	*Steam turbine*
Total weight, lb	88,500	105,000
Heaviest part to handle:		
Before erection, lb	23,500	50,000
After erection, lb	20,000	23,000

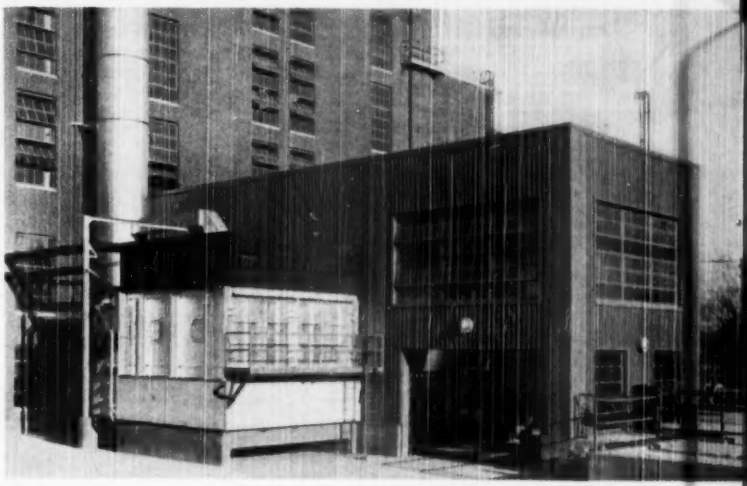
The generator weights are the same for both.

Methods of handling the gas-turbine unit are quite different. It ships assembled on a fabricated steel base or shipping skid, holding the unit in perfect alignment. Light weight makes it easy to lift the turbine-compressor unit off its skid after it has been positioned. Since all units of this size are standard, they have fixed dimensions to all major setting points. Using alignment fixtures becomes inexpensive and speeds up the work.

Basically, installation procedure consists of lining up coupling between gas-

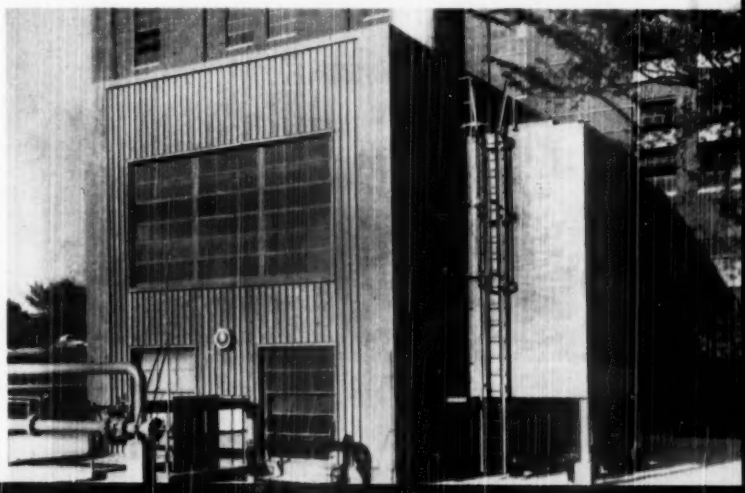


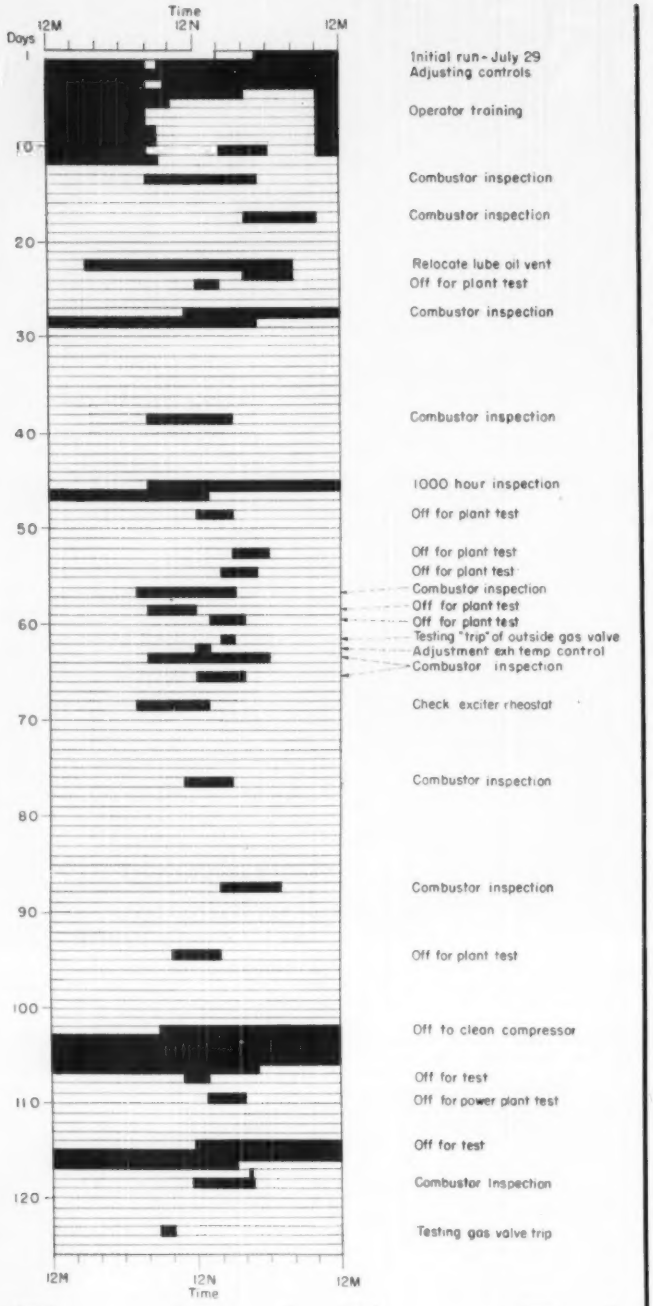
2 Complete gas-turbine control board stands facing generator. Six-position control switch (labeled) controls unit completely from start to stop operation



3 Gas-turbine house abuts main building. Recuperator, left foreground, heats feedwater with turbine-exhaust gas. Exhaust stack stands behind the recuperator

4 Inlet air to axial-flow compressor passes through precooler, at right of gas-turbine building. Well water cools the air, increasing both unit capacity and efficiency





Period	Hours	%	Period	Hours	%
Time in service	2514	84.1	Scheduled outage	193	6.5
Time unavailable	474	15.9	Scheduled maintenance	281	9.4
Total period	2988	100.0	Time unavailable	474	15.9
Forced outages				none	

5 Chronological record of initial operating period, from July 29, 1949 through November 30, 1949, shows unusually high availability, absence of major troubles

turbine unit and gear, with a similar lineup between gear and generator. Generator unit includes the exciter and starting motor. Oil tank and miscellaneous small parts are handled separately as with steam units.

Piping up the gas turbine is easier than a steam turbine. Lubrication piping compares with that of the steam unit in respect to oil and water needs. The gas main, a small pipe subject to low pressures, presents no problems in anchoring, cutting and hanging. Compared with the steam lead piping for a steam turbine, much time, effort and money are saved. In addition, there is no extraction piping for feedwater heating, and casing drains are few.

Most steam turbines must lineup their exhaust flanges with the condenser. This means lowering or raising a heavy condenser. The comparable job on the gas turbine lines up its exhaust flange with relatively light ductwork, nowhere near as difficult. One small problem in this respect arises from the expansion allowance to be made for large temperature changes between hot and cold. A flexible joint will take care of this.

Ductwork between precooler and compressor inlet offers no problems.

Light weights and the upward exhaust and inlet need only a slab-type foundation. Fig. 1 shows this with pads for the points of support. Foundation cost compared with a steam turbine is considerably less. The number of field adjustments were much less than normally experienced in any new steam plant.

OPERATION

Uniquely, the installation is almost "self-operating." A complete set of supervisory and control equipment has functioned satisfactorily. A manually operated, 6-point rotary switch starts the unit. Progressive positions take the unit from cold up to control by the switchboard operator, in total elapsed time of ten minutes. Six minutes of this time is used for purging, a safety step that will probably be reduced in the future. No elaborate or prolonged warmup or shutdown programs are needed.

During starting and in operation, the supervisory equipment automatically:

A. Alarms and shuts down from:

1. Fuel failure.
2. Flame failure.
3. Low lube-oil pressure.

B. Alerts with alarm, and then shuts down if trouble is not corrected from:

1. High exhaust temperature. When wide open, unit governs on exhaust temperature.
2. High temperature on any main or thrust bearing.
3. Excess vibration.

The plant operators quickly familiarized themselves with the unit. Numerous starts and stops were made during the first week for this purpose.

In the steam plant, an auxiliary engineer has charge of boiler feed pumps, condensers, traveling screens, water softeners, chemical feeders, etc, in the turbine-room basement. With the supervisory equipment on the gas turbine it was believed that the auxiliary engineer could take care of this unit also. For this reason the gas-turbine operating level (the only one) was made the same as the turbine-room basement. This arrangement has proved satisfactory.

INITIAL RESULTS

Through Dec 15, 1949, the unit had been in service slightly less than 3000 hr. Longest continuous nonstop run is 723 hr, with others of 265 and 303 hr. Table II shows operating data up to the date of going to press on this article. When placing the unit in service practically no "bugs" had to be straightened out. The start-up was much smoother all around than for a boiler and steam turbine. Fig. 5 gives a graphical record of the chronological outages of the unit up to Nov 30. The unit has shown remarkable reliability during its initial performance.

Operating and test data verify the performance studies made before initiating the project. Some difficulty from boiler superheater fouling together with condenser fouling, before starting the gas turbine, make the initial results not as good as will be eventually realized. The gas turbine has performed well within contract expectations for both capability and economy. Tests have shown that variation of feeder flow through the recuperator has little effect on station performance or capability, as shown in Fig. 8.

Fig. 6 gives some of the contract data for the gas turbine. Working alone, its heat rate is much higher than a 400-psig 750-F steam plant. Reclaiming heat from the gas-turbine exhaust for feedwater heating greatly improves the value of the fuel fired in the gas turbine. The action simulates the addition of a regenerator to the gas-turbine cycle. A regenerator, however, would only reduce the heat rate of the latter cycle and would not increase capability. The steam-gas combination gains two ways: (1) reduces heat rate (2) increases total capability.

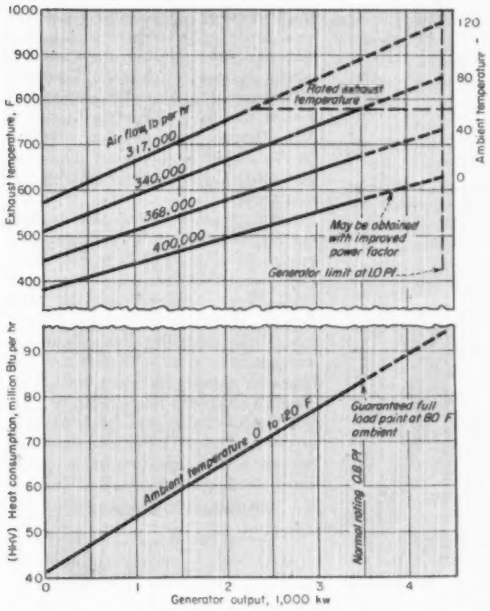
With limited boiler capacity the steam-station capability rises by reducing the steam bled from the turbine for feedwater heating. The gas-turbine exhaust does this heating instead.

Fig. 7 shows the effect of combined operation on heat rates and capabilities. As steam-turbine backpressure increases, heat rates increase and capabilities decrease, but at all levels the gas turbine improves over-all performance of the combination.

GAS-TURBINE PERFORMANCE

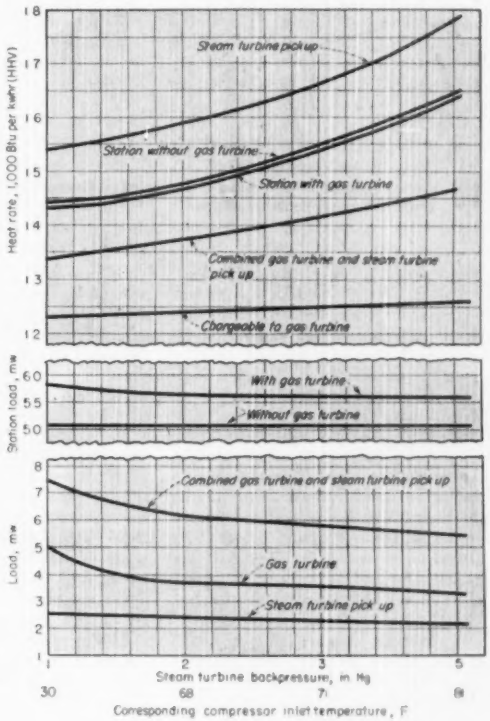
The original design and the materials have been fully justified by their performance. No significant changes are needed.

Fig. 9 shows the heat rates for contract guarantees and actual test. These data have been corrected for altitude, barometer and other conditions. Actual

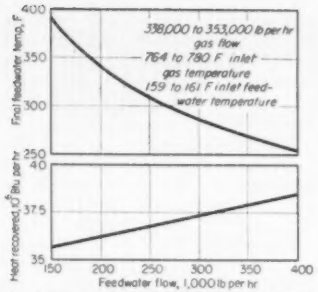


1. For other altitudes multiply output and heat consumption by (atmospheric pressure at altitude/14.696).
2. If waste-heat boiler or other restriction is placed in exhaust, output will drop 1.6% and the specific fuel consumption will increase 1.4% for each percent pressure drop introduced.
3. For gas with a HHV = 1176 Btu per cu ft; LHV = 1066 Btu per cu ft, having 79% methane (CH_4) and 21% ethane (C_2H_6).

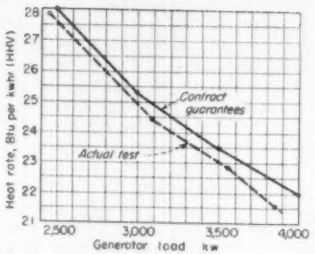
6 Contract performance characteristics for gas-turbine unit specify exhaust-gas temperature and total heat consumption


Heat rate, 1,000 Btu per kwhr (HHV)
Steam turbine pick up
Station without gas turbine
Station with gas turbine
Combined gas turbine and steam turbine pick up
Chargeable to gas turbine
Station load, mw
With gas turbine
Without gas turbine
Load, mw
Combined gas turbine and steam turbine pick up
Gas turbine
Steam turbine pick up
Steam turbine backpressure, in Hg
Corresponding compressor inlet temperature, F

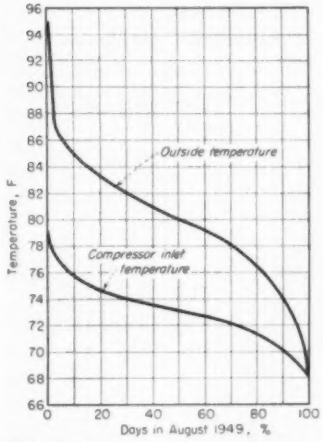
7 With increasing steam-turbine backpressure and compressor inlet-air temperatures, heat rate increases, output drops


338,000 to 353,000 lb per hr gas flow
764 to 780 F inlet gas temperature
159 to 161 F inlet feedwater temperature
Final feedwater temp, F
Heat recovered, 10⁶ Btu per hr
Feedwater flow, 1,000 lb per hr

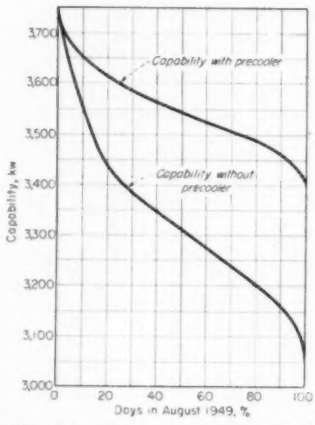
8 Large variation in feedwater flow affects the heat recovery only slightly



9 Actual heat rate of gas-turbine unit is 1.6 to 4% less than guaranteed



10 During August 1949, precooler decreased inlet-air temp on most days



11 Precooling of compressor air raises capability during hot summer days

performance is better than guaranteed.

During the first 100 days the unit was on whenever it was needed. It was shut down periodically for combustor inspection. Natural gas was first used for firing the gas turbine in its present location. All factory tests were run on oil. Results have shown gas to be an ideal fuel. After the first 100-hr operation, some very small cracks were found in the combustor caps. This was accompanied by small collections of soot in the liners. Rapid temperature changes during frequent starting and stopping caused these conditions. The cracks are insignificant and no increase in length or width has been found during the last several hundred hours' operation. The soot, likewise, has essentially disappeared. Life of the liners will probably be satisfactory. They are easily replaceable and relatively inexpensive.

A small auxiliary blower was installed to purge the equipment automatically during starting and stopping. This blower can be replaced by a manually operated vent. Rotating the compressor by the starting motor can perform the purging duty. The various safety devices and automatic equipment described in the Sept 1948 article have performed very satisfactorily. All this experience indicates that the design may be simplified in succeeding units.

Mechanical operation of the unit has been exceptionally good. Maximum vibration recorded on any of the stationary parts has been ½ mil. The unit was taken off the line after about 100 days' operation and a thorough check made of turbine and compressor elements. Both ends were in excellent condition except for a coating of dirt and oil on the compressor blades.

This was caused by the vapor from the oil vents of the various equipment being drawn into the compressor inlet. The oil acting as an adhesive collected dirt and dust on the blades. The coating extended about halfway through the compressor. Wiping with a cloth removed all the accumulation. The blading showed no evidence of corrosion or erosion.

Air entering the compressor is not filtered. Relocating the oil-vapor vents has solved this fouling difficulty. Normal air-borne dry dirt is not harmful provided no viscous fluid is present.

The blade coating will not reduce the unit's life, but it does reduce the unit capability somewhat. Tests have shown that efficiency is not noticeably affected by this coating.

Results show operation is simpler and maintenance considerably less than for an equivalent-sized steam plant.

RECUPERATOR PERFORMANCE

The recuperator was chosen on the basis of an economic study. It would be possible to recover more heat with additional surface. About 50% of the fuel energy fired in the gas turbine is recovered as heat in the feedwater. At full load this about equals the no-load fuel input. Increment heat rate for the unit from no-load to full load is 12,000 Btu per kwhr.

Recuperator performance closely follows contract predictions. Fig. 8 shows test results obtained by holding turbine-exhaust flow constant and varying the feedwater flow. Recuperator effectiveness for all flows equals about 72%. Gas- and water-pressure drops are well within contract specifications. The water side has been so conservatively designed that it has been possible to pass the entire station feedwater flow of about 600,000 lb per hr through it. This compares with 400,000 lb per hr anticipated maximum.

Average outlet gas temperature from the recuperator is 340 F. This is high enough to preclude trouble from corrosion caused by dewpoint conditions. With "sweet" natural gas the large amount of excess air for combustion places the dewpoint down near the ambient temperature. To date the heat transfer surface has remained very clean. No deposits have shown up. Unless the gas being fired becomes dirty or unusual dust conditions arise, no fouling of the recuperator is anticipated.

PRECOOLER PERFORMANCE

Precooler behavior is best shown by Fig. 10 and 11 covering the hottest month of operation, August. Upper-temperature duration curve of Fig. 10 shows the average actual temperature for the month was only 80 F. The maximum was 96 F and the minimum 68 F. These temperatures would affect the turbine capability as shown by the lower curve of Fig. 11. The other curves on these two figures show that with the precooler running, the average inlet temperature to the compressor was

TABLE I—GAS-TURBINE INSTALLATION COST

Buildings, grounds and foundations	$ 79,851
Gas-turbine unit erected	400,107
Automatic control	28,393
Recuperator erected	91,140
Stacks, ductwork	32,548
Air-intake cooler*	9,237
Piping	51,225
Electrical equipment	34,486
Miscellaneous items	3,013
Total installed cost	$730,000

* For installation and related expense only. Precooler is a generator air cooler previously taken out of service.

TABLE II—OPERATING DATA THROUGH JAN 8, 1950

Date in service	July 29, 1949
Total hours in operation	3,433
Total generation, kilowatt-hours	13,310,000
Average load, kilowatts	3,877
Maximum load, kilowatts	5,000
Unit capacity factor, percent	110.8
Average inlet-air temperature, F	59.6
Average exhaust temperature, F	779
Average fuel rate to turbine, million Btu per hr	80.7
Average feedwater temperature to recuperator, F	149
Average feedwater temperature from recuperator, F	340
Total capability increase for station at time of maximum load on gas turbine, kilowatts	7,400
Station heat rate for period, Btu per kwhr	15,397
Average temp of flue gas leaving recuperator, F	330

73 F, the maximum was 79 F, and the minimum, 68 F. The gas-turbine capability has been correspondingly improved.

Without the precooler the capability would have averaged 3300 kw. Maximum would have been 3940 kw, and minimum 2780 kw. With the precooler the actual capability averaged 3540 kw with a maximum of 3940 kw and a minimum of 3410 kw. The following conclusions can be drawn:

1. With the precooler, firm capability of the unit increased 630 kw, or 22.7% over that available without this element.

2. With the precooler, average capability increased 225 kw or 6.8%. This accounted for an additional 122,000-kwhr generation during the month of August.

The precooler has shown an effectiveness of about 55% under maximum conditions with deepwell water entering at 63 F.

The above capability figures are small considering they are on a system having peak loads of over 300,000 kw. But when we look at the percentage values as applied in this particular unit, the effect is appreciable. By evaluating the gain in firm capability at $125 per kw, and the saving from the additional kwhr generated by the higher average capability at the 12,000-Btu-per-kwhr increment heat rate, we found that an investment of over $75,000 in a precooling system would be justified.

SUMMARY

This application of the first gas turbine on a utility system has been outstandingly successful. Ability of the unit to burn natural gas as a fuel has been proved beyond question. Some apprehension existed as to (1) hazard (2) noise and (3) exorbitant maintenance. By using the same precautions applying to gas-fired boilers for the gas turbine, operating hazards have been minimized.

Noise level within the gas-turbine building is somewhat above that of a conventional steam turbine. From outside the building, however, it is not possible to detect whether the unit is running.

As to maintenance, the total cost to date has been only $1079. Makeup lube oil has been one barrel, or, stated in terms used for other internal-combustion engines, about 250,000 hphr per gal. Some loss of capacity was encountered from compressor fouling. This was not unexpected. It is believed the revision in the lube-oil system vents will prevent a recurrence. The recuperator has demonstrated that it is a very efficient link between a gas-turbine unit and a steam-turbine generating station. A precooler cannot be economically omitted when the gas turbine operates in locations having hot summers.

Operation and maintenance of the unit has been quite simple and easily picked up by the existing plant personnel.

The over-all effect on the station, by actual operation, has been found to permit carrying a load of 58,000 kw under worst summer conditions. Normal operation follows the data as presented in the various figures. Such operation has allowed the rating of the station boilers to be dropped enough to favor maintenance requirements.

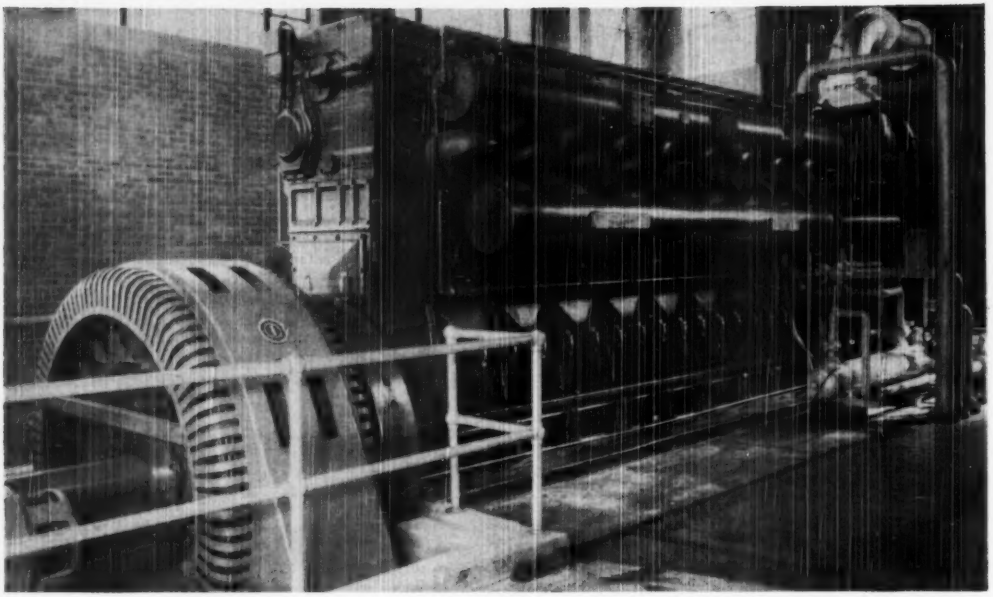
Practically all phases of the installation have been put in final form. One exception is the expansion joints between the turbine-exhaust and recuperator duct. The extremely low permissible loading of the turbine-exhaust nozzle, together with the relatively high temperature (780 F), has caused a delay in placing the final joints. Study of this problem has been completed and these joints will be installed in the near future.

Although some phases of this application of a gas turbine have been special, it is believed that the efficient use of exhaust heat transferred to feedwater should be applicable to other existing and new stations.

COAL-BURNING GAS TURBINE MAKES TEST RUNS

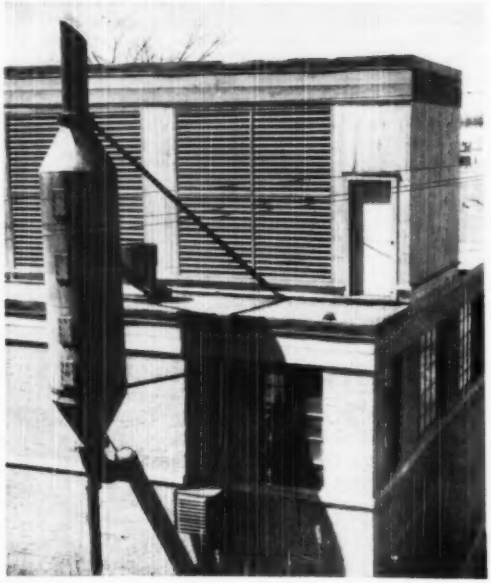
► THIS MONTH'S COVER shows the first complete gas-turbine unit to run on pulverized coal. It is a Houdry-process unit built by Allis-Chalmers Manufacturing Co. U. S. Bureau of Mines loaned it to the Locomotive Development Committee for this testing. Inspection of the unit following a 38-hr run, equivalent to a round-trip by rail between New York and Chicago, showed all components of the coal-burning gas-turbine plant in excellent condition. Combustion efficiency of over 90% and performance of the ash-removal equipment pleased the committee.

Laboratory work preceding present series of tests was done under supervision of J I Yellott, director of research. Some participating organizations are Battelle Memorial Institute, Johns Hopkins University, Institute of Gas Technology, Turbodyne Corp.

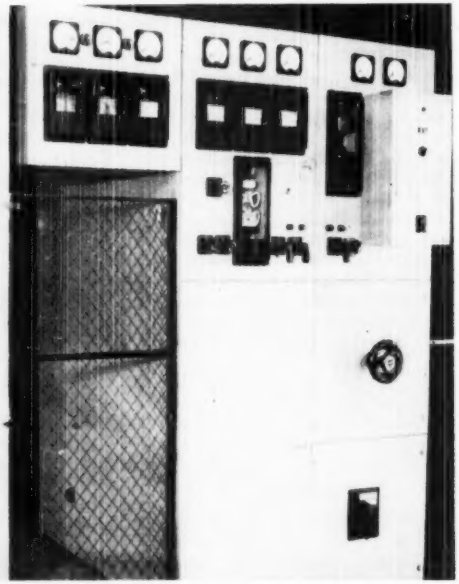


1 This supercharged 1500-hp diesel went into service at the Houlton plant on Jan 15, 1949. During initial operating period, working at low-load factor, it averaged 13.23 kwhr per gal of fuel. Turbocharger can be seen at engine's rear end

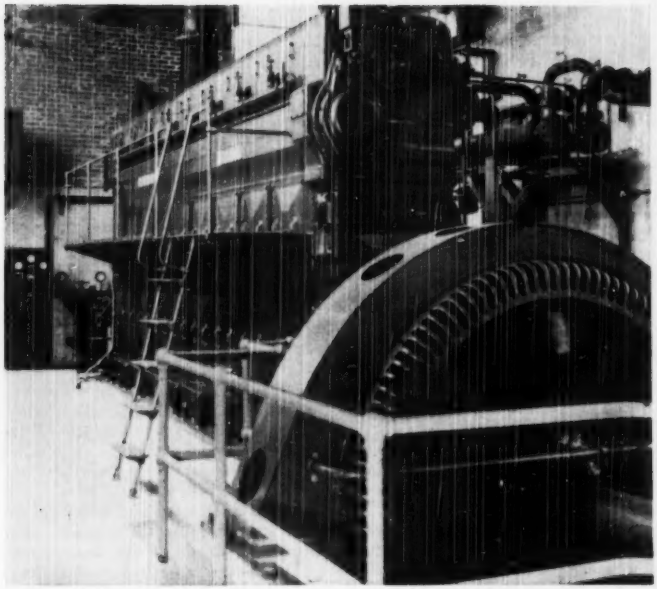
Diesels in Hydro Country Save Stored



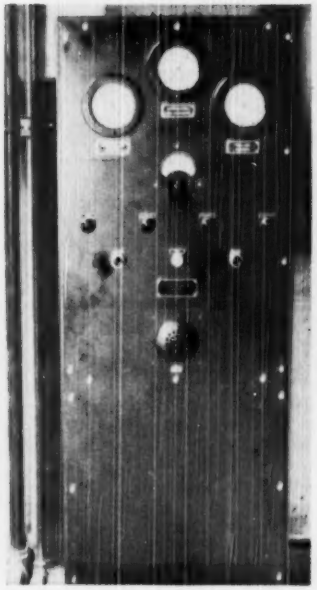
4 At Houlton, with no economical supply of raw water available, radiators are used, installed in housings on roof



5 Switchgear at Houlton plant is fully enclosed, metalclad type, with voltage regulator and full complement of meters



2 Diesel at Tinker plant is identical with that at Houlton. Turning over at 360 rpm, it drives 1000-kw 4100-v 3-ph 60-cycle generator with V-belted exciter



3 Control panels at each plant are similar and mounted close to the engines

Water, Replace Purchased Peak Power

Installed after 1948's severe drought conditions, diesel sets in Maine and New Brunswick turn in good performance, improve over-all system economy, protect against weather variations

► How DIESELS MAY EARN their keep in country predominantly hydro has been shown by recent experience in the far northeastern corner of the U. S., where Maine and New Brunswick, Canada, meet. It resulted from a cooperative program in which the city of Houlton, Me., joined forces with the Maine-New Brunswick Electrical Power Co, Ltd, an operating subsidiary of Maine Public Service Co. Their immediate aim was to conserve stored water and insure dependable power supply in times of water shortage. Right now the diesels are pressed into service to handle peak demands beyond the capacity of the hydro system. Their output thus replaces more-expensive purchased power.

Engine installed at Houlton is a 1000-kw Superior diesel, capable, incidentally, of carrying the city's normal residential load. An identical prime mover at the Tinker, New Brunswick, hydro station adds another 1000 kw to Maine Public Service's system.

Reasons Why. When hydro power is readily available, there is no question of its economic advantages. This is particularly true at a time when fuel costs are high and in an area where cost of fuel transportation bulks large. Unfortunately, hydro power depends on the weather, and peak water supply doesn't necessarily match peak load demand. The unpredictability of water power was brought home to Maine residents dramatically during the winter of 1947-48, when a severe drought virtually dried up the rivers.

Maine Public Service was hard hit and severe rationing went into effect. This meant: (1) as little as one hour's service in three to residential customers (2) curtailed business hours for commercial users, and (3) either night shifts, sharp curtailment, or complete shutdown for industry. Emergency measures, notably the use of power from two U. S. Navy vessels, cushioned the blow. But the situation stressed the need for fuel-burning auxiliary plants, and work was rushed on the long-planned permanent diesel plant at Caribou, one of the company's hydro stations.

Cooperative Action. The crisis also brought to swift fruition negotiations between Maine Public Service and the Houlton Water Co. The latter is a municipally owned utility, which provides power, water and sewage service for Houlton's 8000 population. The city handled sale and distribution of electricity but found it economical to purchase hydro power at wholesale rates from the private utility.

Maine Public Service's long-range development program included plans for several diesel plants to augment hydro production and conserve stored water for use when needed most. Spurred by the drought, the company altered its timetable, marked all projects "immediate" and "urgent," and marshaled avail-

able resources to meet the emergency and prevent recurrence of the power shortage. The Houlton Water Co agreed to cooperate in this program by building a diesel plant for operation, and eventual purchase, by Maine Public Service.

Houlton Agreement. Under the agreement, Houlton was to purchase the equipment and construct the plant, issuing $170,000 in bonds. Maine Public Service would then purchase the plant over a 10-year period by meeting interest and principal payments as they came due. Houlton would retain title until the plant was paid off and would have the option of repurchasing (at cost less depreciation) at the end of the ten years. Meanwhile Maine Public Service would assume full responsibility of operation and maintenance.

Action under this agreement was strongly influenced by experience at the Caribou plant, where diesels had proved themselves under difficult emergency operating conditions. The first unit at Caribou, a 7-cyl 16x22-in. 4-cycle supercharged Nordberg, rated 1425 hp at 327 rpm, went on the line just before Christmas 1947. With the shortage becoming increasingly critical, utility officers purchased a 1500-hp Superior engine, which was available for immediate delivery. The engine was promptly installed on a foundation intended for a second unit of 3600 hp, and went into service the evening of Jan 24, 1948.

By the end of January, this unit had already generated 108,160 kwhr. In February, the unit's production was 629,800. By the end of 1948, with the emergency just a bitter memory, this one diesel had clocked 3,528,540 kwhr. In July of that year, a 3600-hp Nordberg went into operation. Then the 1500-hp Superior was moved to its own foundation and a second 3600-hp unit was installed on the No. 2 foundation.

The Caribou plant was under construction during most of this period, and operating conditions were exceedingly difficult. Yet during 1948 the Caribou diesels generated more than 13 million kwhr, averaging slightly better than 13 kwhr per gal of fuel.

On the basis of this performance, Public Service and Houlton engineers decided to put a 1500-hp Superior into the new Houlton plant. This engine, an 8-cyl 14.5x20-in. 360-rpm 4-cycle supercharged unit, went on the line Jan 15, 1949. In the first four months, though operated at low-load factor, it averaged 13.23 kwhr per gal.

Tinker Installation. Next step in setting up a dependable power supply for the region was the installation of another 1500-hp Superior diesel generator set at Tinker, N. B. The diesel plant was built as an addition to the existing hydro station. It started to make its own contribution on March 2, 1949. By the end of April, the engine had produced 64,000 kwhr. Load factor was good and fuel performance averaged 14.41 kwhr per gal.

As might be expected, accessory equipment and the handling of fuel, lubricating oil and cooling water for the Houlton and Tinker units are similar. The only differences are minor, dictated by local conditions. Each engine direct-connects to a 1250-kva 1000-kw 3-phase 60-cycle generator. Voltage is 4100 for direct connection to the transmission system.

Cooling Water. As part of the hydro station at Tinker, the diesel plant enjoys a convenient source of cooling water. Raw water flows from the penstock to a header that serves a heat exchanger and the hydro bearings. With 25-ft head available, no raw-water pumps are needed. A 550-gpm motor-driven centrifugal circulates soft water through the engine and heat exchanger.

Since there is no economical supply of raw water at Houlton, a dual radiator system cools the engine. A 550-gpm centrifugal pump driven by a 15-hp motor circulates soft water through the radiators and the engine jackets. Radiators are in housings on the plant roof. In deference to the rigors of the Maine climate, 200 gal of antifreeze protects the 500-gal system. An automatic thermostatic regulator keeps engine-water temperature at prescribed level by bypassing water around the radiators. Similar regulators at Houlton bypass raw water around the heat exchanger.

Fuel System. Engines use No. 2 diesel fuel. Both plants are below railroad tracks on high embankments so it is easy to unload tank cars by gravity. At Tinker there are two storage tanks, each of 10,000-imperial-gal capacity. Houlton has one 25,000-gal tank. Motor-driven rotary pumps, in each case controlled automatically by day-tank floats, transfer fuel through a strainer and meter to an elevated day tank in the engine room. Built-in engine pump takes fuel through a duplex filter and supplies it through a header to the individual injection pumps for each cylinder.

Economies of space and weight result from supercharging the engines. The charger is driven by an exhaust-gas turbine; it forces fresh, filtered air into the cylinders under pressure. Air for each engine is drawn through a 4-element viscous-impingement filter, outside the plant building. Exhaust from superchargers vents through vertical silencers.

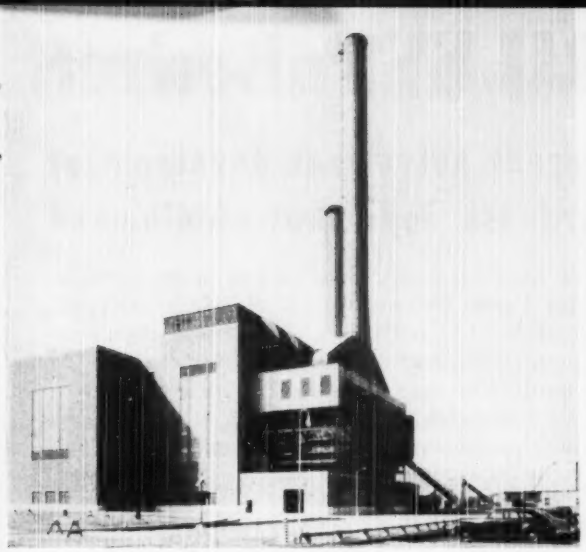
Lubrication. On each engine, a built-in pump supplies a full-pressure lubrication system. A motor-driven auxiliary pump cuts in automatically if engine lube-oil pressure drops. The auxiliary also serves during start-up and shutdown. In each lubricating-oil circuit there is an oil cooler and three filters: an edge type, a duplex bag-type, and a multi-element cellulose cartridge.

A control panel near each engine helps make operation smooth and easy. It carries pushbutton switches for auxiliaries, pressure gages, exhaust pyrometer and a complete alarm system. This warns of low engine or turbocharger lube-oil pressure, overspeed, or high jacket-water temperature.

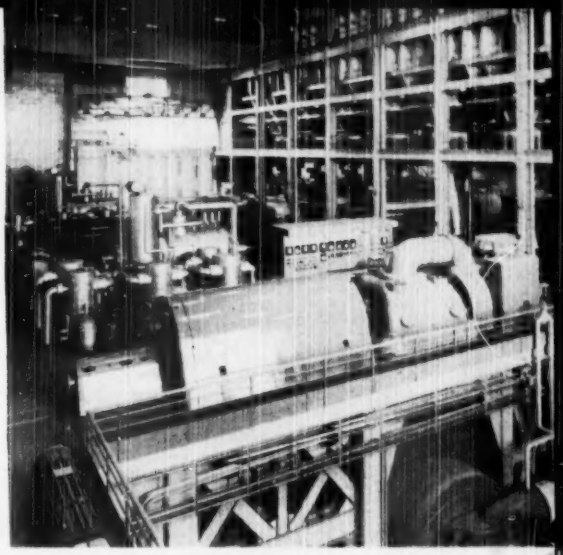
PRINCIPAL EQUIPMENT IN POWER PLANTS

City of Houlton, Me., and Tinker, N. B. plant of Maine Public Service

Diesel engines	Superior Engine Division, National Supply Co
Each plant has one Model 80-EX, 8-cyl, 14.5x20-in. 360-rpm 1500-hp Superior diesel	
Turbochargers, Elliott-Buchi	Elliott Co
Generators—Houlton	Ideal Electric & Mfg Co
Tinker	General Electric Co
Air compressors	Quincy Compressor Co
Cooling-water pumps, 550 gpm	Yeomans Brothers Co
Radiators—Houlton only	Young Radiator Co
Heat exchangers	Graham Mfg Co
Water strainer, twin—Tinker only	Elliott Co
Governors	Woodward Governor Co
Fuel-oil meters	Neptune Meter Co
Fuel filters	Purolator Products, Inc; Andale Co
Air filters	Air Maze Corp
Silencers	The Maxim Silencer Co
Auxiliary lube-oil pumps	Geo D Roper Corp
Lubricating-oil filters—Houlton	Purolator Products, Inc
Tinker	Fram Corp
Lubricating-oil coolers	Graham Mfg Co
Lubricating-oil bypass filters	Wm W Nugent & Co, Inc
Temperature regulators	Fulton Sylphon Corp
Control-panel alarms	Edwards & Co, Inc
Exhaust pyrometers, Alnor	Illinois Testing Laboratories, Inc
Control panels	National Supply Co
Switchboard—Houlton	Northeastern Engineering Co
Battery system, Exide	Electric Storage Battery Co
Vibration isolation, cork	Korfund Co, Inc



PLANT EXTENSION FOR TWO UNITS is fully housed except semi-outdoor construction of draft system with enclosed fans

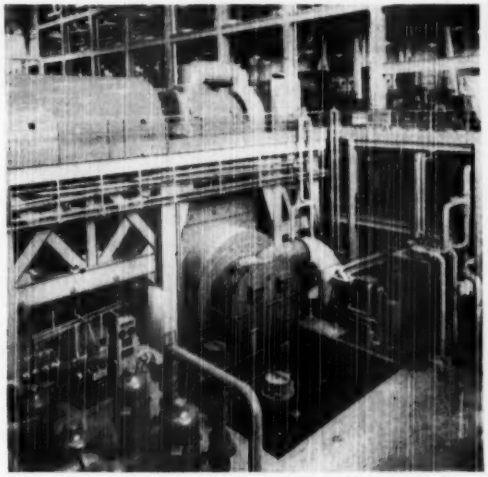


TURBINE OPERATING FLOOR opens directly onto boiler-room floor and also carries feedwater heaters and evaporators

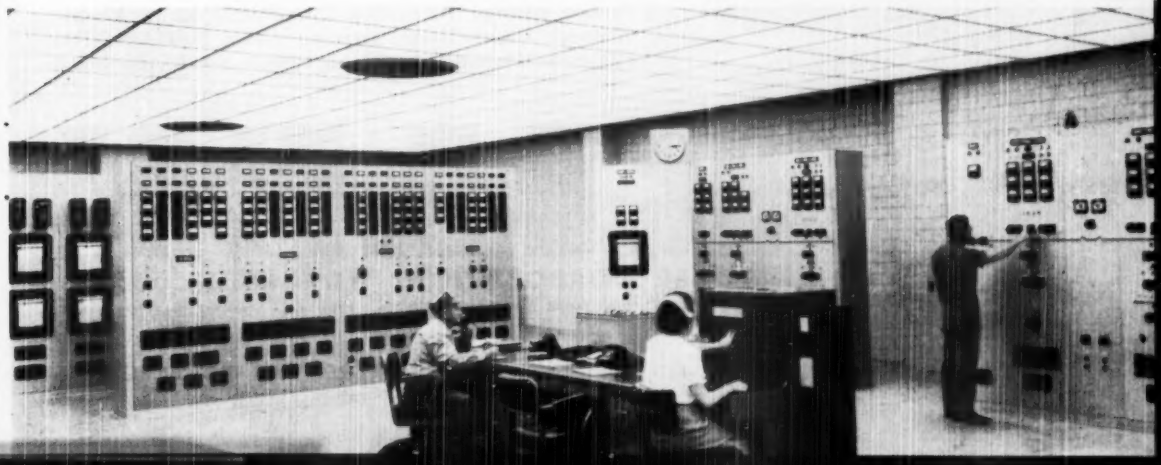
Barbadoes Station

Philadelphia Electric Co places in service two new 60,000-kw preferred-standard units. Each turbine is supplied by one 600,000-lb-per-hr steam generator, no cross connections between units. Boilers can burn coal, oil or gas, but pulverized coal is main fuel. Plant extension raises station capacity to 180,000 kw. Engineered by owners, constructed by Dravo Corp

CONTINUED ON PAGE 108

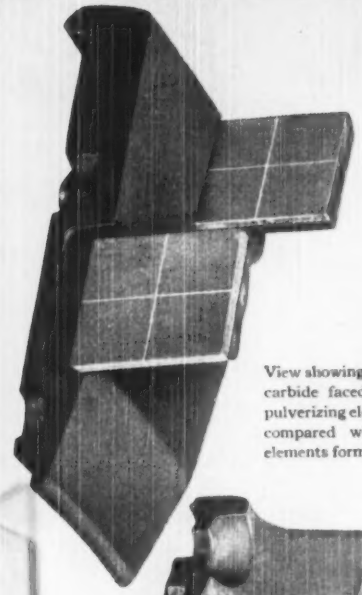


37,500-SQ-FT CONDENSERS have two water passes and deaerating hotwells, are served by two 20,000-gpm circulating pumps

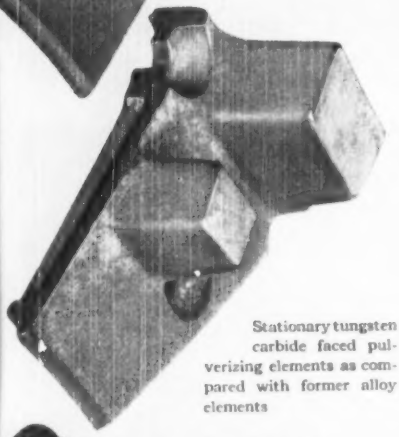


MAIN CONTROL ROOM for entire station features completely luminous ceiling to remove shadows, produces 25 foot-candles

Now RILEY Pulverizer



View showing tungsten carbide faced moving pulverizing elements as compared with alloy elements formerly used



Stationary tungsten carbide faced pulverizing elements as compared with former alloy elements

A great pulverizer development
Hardness near that of diamond

The use of tungsten carbide facings on Riley pulverizer parts adds tremendously to the life of the parts. Such parts when pulverizing sand to accelerate wear have outlasted six sets of alloy parts without showing any measurable signs of wear. Hardness of tungsten carbide approaches that of the diamond. Experiments and developments with the use of tungsten carbide pulverizer parts were started by Riley over ten years ago.

GREATLY REDUCED MAINTENANCE

While Riley pulverizers in actual use have been in operation with tungsten carbide parts for over two years, there is still no appreciable evidence of wear. These parts are good for many more years of service. Such long life results in greatly reduced maintenance costs placing the Riley pulverizer in a field by itself.

SUSTAINED FINENESS OF PULVERIZATION

Riley pulverizers equipped with tungsten carbide parts have shown no decrease in fineness of pulverization even after many times the amount of coal has been pulverized that formerly required replacement of parts. The fineness chart shows typical experience. As no wear is discernable to the carbide facings installed in these pulverizers, fineness will be maintained for many more thousands of tons of coal. No adjustments whatsoever are required to maintain fineness.

APPLICABLE TO EXISTING PULVERIZER

In keeping with Riley's policy of developing improvements which wherever possible can be applied to existing pulverizers, tungsten carbide parts can be installed in connection with most existing pulverizers. Many Riley pulverizer users have modernized their machines by applying this improvement. The following companies are a few of the many who have applied this improvement: Lynn Gas & Electric, Central Ohio Light & Power, Edison Electric Illuminating, Iowa-Illinois Gas & Electric, Potomac Electric Power, American Viscose, New York, New Haven & Hartford R.R., General Electric, Crocker-Burbank & Co.

TRADE MARK Rx REGISTERED

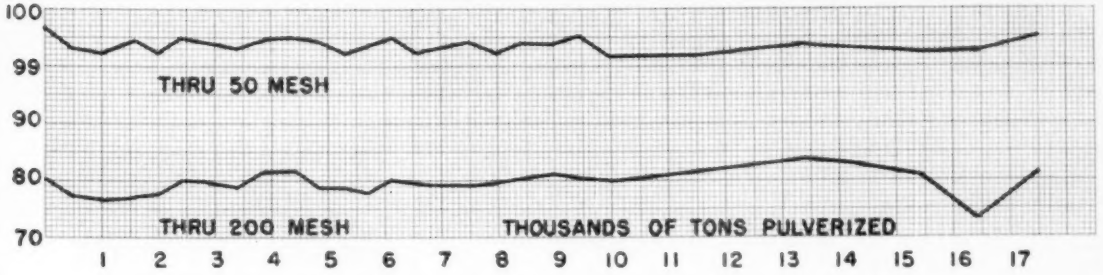
RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Washington Buffalo Pittsburgh Cleveland Detroit Chicago
Cincinnati Atlanta New Orleans Memphis St. Louis Kansas City St. Paul Tulsa Houston
Denver Salt Lake City Los Angeles Portland Seattle

BOILERS · PULVERIZERS · BURNERS · STOKERS · SUPERHEATERS · FLUE GAS SCRUBBERS

Parts with Tungsten Carbide Facings



Fineness against tons of coal pulverized. Fineness variations of any magnitude due to varying grindability.

Other operating advantages . . .

in addition to long life, low maintenance and sustained fineness of pulverization.

Flexibility—Wide Load Range

As change in coal feed gives instantaneous corresponding change in pulverized coal output—there is no lag—rapidly and widely fluctuating loads are efficiently and easily carried.

Ability to Carry Low Loads

With the combination of Riley pulverizers and burners, extremely low loads with stable ignition can be maintained. It is not unusual for load ranges of 10 to 1 or for loads under 5000 pounds of steam per hour to be carried at Riley installations.

High Primary Air Temperatures

There is no necessity of limiting primary air temperatures as a precaution against fire or explosion or because of lubricating problems. Expensive control equipment limiting primary air temperatures is not required.

Ability to Handle Wet Coals

With Riley pulverizers coal is pulverized in complete suspension, and not between two surfaces, affording the most effective drying effect from the hot air passing through the pulverizer.

Ease of Lighting

Because of small percentage of primary air, a rich and readily lighted mixture of air and coal is obtained which together with the uniform distribution with Riley burners makes lighting easy and gives stable flame at low loads.

Quiet, Vibrationless Operation

There is no comparison between Riley pulverizers and other makes insofar as quiet vibrationless operation is concerned. You hear nothing more than a motor hum.

Small Space Required—Minimum Foundations

Riley pulverizers require less space per unit of capacity. Massive deep foundations are not required due to their vibrationless quiet operation.

Explosion Proof

There has never been an explosion in a Riley pulverizer. The velocity of coal travel through the pulverizer is faster than the rate of flame propagation, eliminating the possibility of an explosion.

These Companies have installed Riley Pulverizer equipment

NORTHERN VIRGINIA POWER CO.
Riverton Station

IOWA ILLINOIS GAS & ELECTRIC CO.
Davenport, Iowa

CARNEGIE ILLINOIS STEEL CORP.
Carrie Furnaces, Rankin, Pa.

OTTER TAIL POWER CO.
Crookston, Minn.
Hoot Lake, Minn.

PENNSYLVANIA ELECTRIC CO.
Williamsburg, Pa.

CAROLINA POWER & LIGHT CO.
Moncure, N. C.

UTAH POWER & LIGHT CO.
Provo, Utah

EDISON ELECTRIC ILLUMINATING CO.
Boston, Mass.

MONSANTO CHEMICAL CO.
Everett, Mass.

WEST PENN POWER CO.
Milesburg, Pa.

SOUTHERN IND. GAS & ELECTRIC CO.
Evansville, Ind.

KENNECOTT COPPER CO.
Chase Brass & Copper Div.
Waterville, Conn.

RIEGEL TEXTILE CORP.
Ware Shoals, S. C.

BIRD & SONS
E. Walpole, Mass.

ARMSTRONG CORK CO.
Beaver Falls, Pa.

CALUMET & HECLA CONSOL. COPPER CO.
Calumet, Mich.

HOOKER ELECTRO CHEMICAL CO.
Niagara Falls, N. Y.

CONTAINER CORP. OF AMERICA
Manayunk, Philadelphia, Pa.

CELANESE CORP. OF AMERICA
Narrows, Va.

COLUMBIA RECORDS, INC.
Bridgeport, Conn.

CROCKER-BURBANK & CO.
Fitchburg, Mass.

SAVANNAH SUGAR REFINERIES
Savannah, Ga.

C. H. MAILAND & SONS
Carlisle, Pa.

HORLICK'S CORPORATION
Milwaukee, Wis.

A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large savings in your power costs

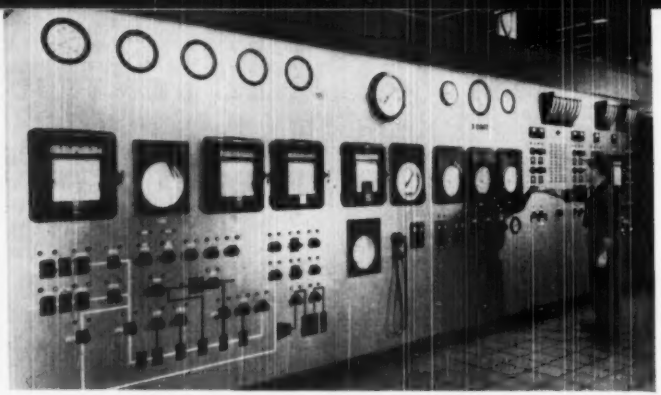
COMPLETE STEAM GENERATING UNITS

. . . it will pay you to visit modern Riley Installations before purchasing Boiler or Fuel Burning Equipment

ECONOMIZERS · WATER-COOLED FURNACES · STEEL-CLAD INSULATED SETTINGS · AIR HEATERS

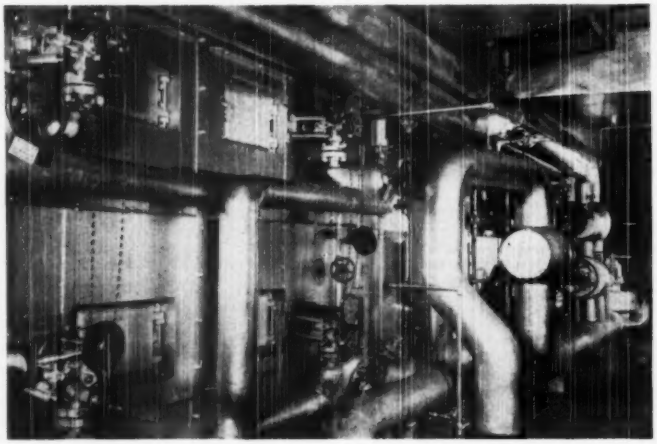
More Views Around Barbadoes

(*Continued from page* 105)



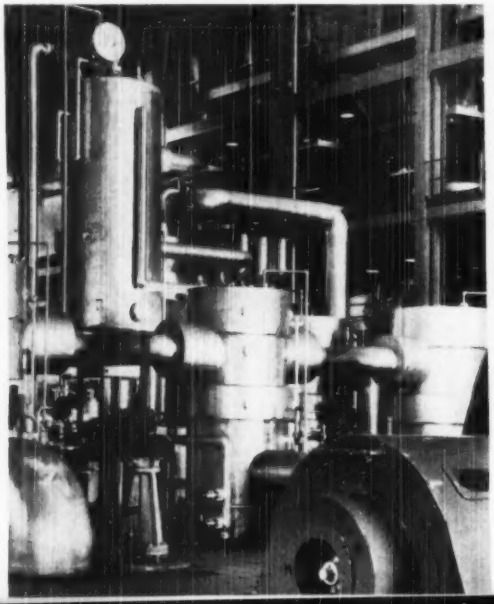
OPERATION OF ONE STEAM GENERATOR together with automatic combustion-control system is centralized at this board. It supervises all boiler auxiliaries

ENCLOSED CONVEYOR moves 12,000 tons coal a day in from breaker house

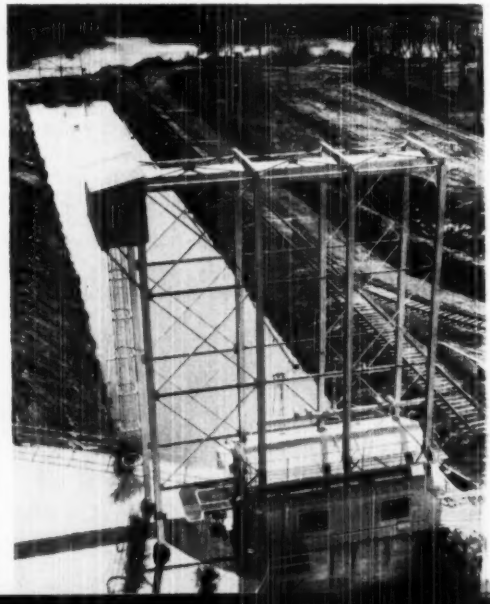


EACH MAIN STEAM GENERATOR is fitted with ten retractable-type and eight rotary-type soot blowers taking steam from main drums reduced to 300-psig pressure

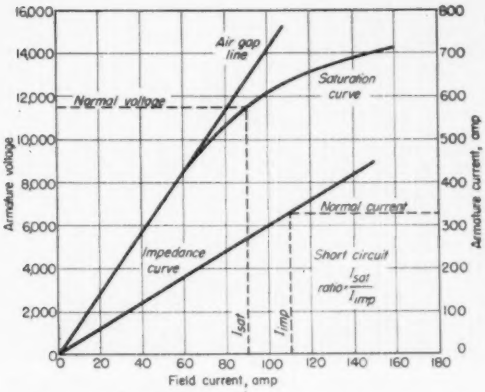
FIVE VERTICAL FEED HEATERS fed from as many bleed points in turbine are placed between l-p and h-p boiler feed pumps



SCREEN HOUSE for circulating-water intake passes water from Schuylkill River and also chlorinates it before use in plant



By E W BURSTADT and C B FONTAINE, *Turbine Divisions, General Electric Co*



TYPICAL CHARACTERISTICS of a generator show how short-circuit ratio is figured from saturation and impedance curves

GENERATOR STABILITY DEPENDS ON SEVERAL FACTORS

Turbine Specialist,
District Office.

Dear Mr Specialist,

I want to be sure of getting a stable generator—one that will not lose voltage when ordinary amounts of load are thrown on suddenly and will keep carrying its load even when subjected to wide load fluctuations. Can I get such a generator by specifying that the short-circuit ratio shall not be less than 0.85?

Very truly yours,
ENGINEER

Dear Mr Engineer,

Stability is a system problem increasing in importance as generators are added to a system and different load types taken on. Surprisingly, the best way to get stability does not directly concern the generator. It depends on having a modern voltage regulator attached to the generator-excitation system. With such a system the exact value of short-circuit ratio for most applications is relatively unimportant.

System stability is complex: (1) *Steady-state stability* depends largely on generator characteristics but only when excitation is manually controlled. (2) *Transient stability* depends almost entirely on quick removal of system short circuits. It needs fast relaying, quick-acting circuit breakers.

Because power systems are complex, steady-state stability measures have been most often based on generator characteristics without regard to the rest of the system. Graph shows that generator short-circuit ratio can be easily determined. This old-fashioned textbook indicator is valid only to compare generators of like construction under limited conditions of steady-state operation. Ratio of field current, required for normal voltage on open circuit, to the field current needed for normal armature current on sustained short circuit equals the short-circuit ratio.

It is a rough indicator of inherent steady-state generator stability under manual field control. A higher short-circuit ratio corresponds to an oversize generator that operates at a smaller load angle (field shift from no-load to full-load position). Remember, generator output corresponds to stretching its magnetic field (like a spring), by twisting the field poles away from no-load position. With a smaller load angle at rated output and 0.8 pf, generator could deliver more power in sudden load changes. Likelihood would be less of slipping into the unstable region corresponding to a load angle of 90 electrical degrees or more.

Emphasis on high values of short-circuit ratio persists from the days before good regulators were available. Good ones can begin to produce field-current change within 0.05 to 0.1 sec after a fault or load change. Increasing the field current raises the stability margin. Then with a good regulator a generator does not have to carry as much field current continuously as it would otherwise.

Short-circuit ratio will probably designate generator stability characteristics for some time. But the trend of its magnitude is definitely downward. AIEE-ASME preferred standard generators, 11,500 kw and up, have a specified scr of 0.8 at nameplate rating. Many generators built for foreign installation operate satisfactorily with ratios of about 0.65. For many years European practice has called for values of 0.5 and below, even for large central-station units.

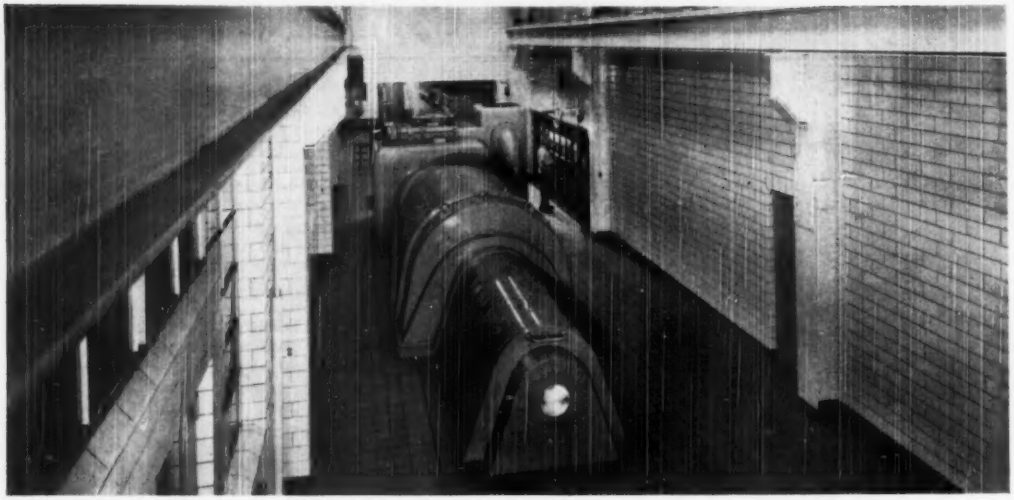
Industrial and central-station engineers agree that scr for generators in industrial-plant sizes can be reduced below present levels without instability. The question arises in rare instances, as when a unit operates at low pf, underexcited in charging a long transmission line.

As fast as experience proves it practicable, with users' acceptance, manufacturers will take advantage of low scr's to improve generator designs in other ways. Inherent short-circuit reactances increase nearly in proportion to the decrease in scr. This means smaller switchgear and fewer or smaller external reactors, a factor of increasing importance to turbine users. Smaller generators and improved efficiency would result.

To sum up, generator stability is only one part of system design. System stability is assured when all parts, including generator, voltage regulator, excitation system, relaying, high-speed circuit breakers, turbine governor, are properly applied. Standard generators are designed to have stability for ordinary conditions.

In generators, stability is considered along with other important features, like reactances, efficiencies and heating for best over-all design. For usual service, better specify a standard generator. As machines are now built, only in unusual conditions (for instance, in charging long transmission lines) are departures from standard warranted. In such cases give the information to the builder so design can take care of the unusual requirement. Thus you avoid buying expensive special equipment that is not really needed.

Sincerely yours,
TURBINE SPECIALIST



1 Changeover from steam- to motor-drive of much of the plant equipment required a 7500-kw turbine, above, to carry the load. All the former coal-handling system was shifted outside and turbine-room, boiler feed pumps, etc, put in its place

Paper-Plant Modernization Proves That

River Raisin Paper Co ran a thorough engineering survey before modernizing. It revealed ways of stopping losses, loads that could be combined, and power applications to improve

By **ANDREW A CUMMINS**, *Cummins & Barnard, Inc, Ann Arbor, Mich.*

► THERE COMES A TIME in a plant's growth when an engineering survey can lead to substantial operating savings. River Raisin Paper Co, Monroe, Mich., called in Cummins & Barnard Inc, consulting engineers, and their findings proved this true. The survey took considerable time. All lines whose steam consumption affected the appraisal had orifices put in to measure flow.

Principal users were one 1000-kw condensing turbine and one 2500-kw unit; two 500- and one 350-kw engine generator sets operating noncondensing; one 1500-kw noncondensing turbine. This equipment along with three dc engine generator sets made up the electrical generating equipment. Throughout the plant 16 steam engines drove beaters, Jordan line shafts, five paper machines, fans and various other pieces.

Survey Conclusions. Steam for these machines and all process needs came from five 200-psi boilers operating with no superheat at 170 psig. Each boiler had a capacity of 70,000 to 80,000 lb per hr. When all steam-flow figures were tallied, engine indicator cards taken, production outputs totaled, fuel and power amounts added, the following conclusions were drawn:

Heat losses were heavy. They occurred chiefly in turbine-condenser cooling water eventually discharged to the sewer—about 18% of all Btu as purchased in the coal.

Eliminating condensing turbines and changing over from steam drives throughout the plant to motor drives would pay. Plant electrical load would then be about 9000 kw.

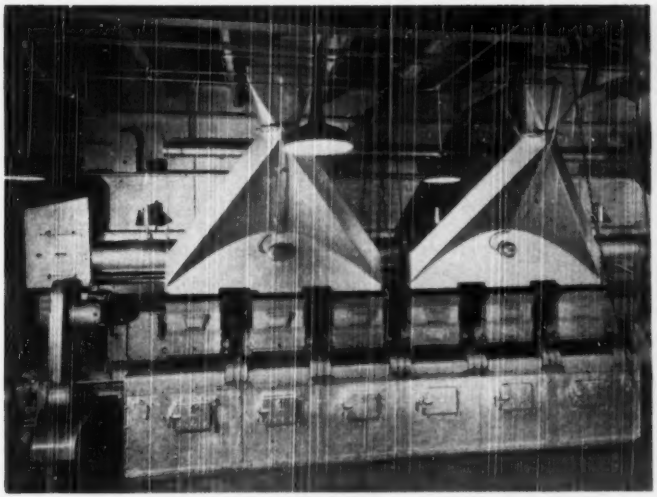
Steam demands of building heating, drying paper, supplying hot process water, feedwater, etc, would give enough steam to generate, noncondensing, all the estimated electrical power needs for most of the time.

A 7500-kw 0.7-pf turbine-generator, receiving steam at 600 psig, 750 F, extracting at 175 psig, and operating at 30-psig backpressure, could carry the electrical load at a system power factor of 0.84.

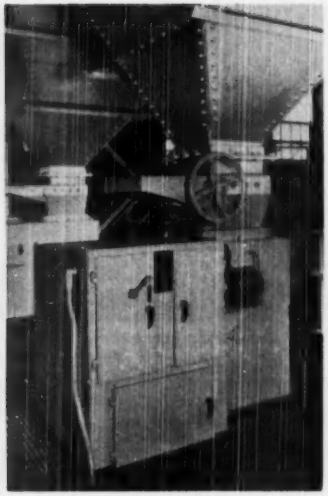
A comparison of operating costs in heat units makes up table, p 112. Calculations behind comparison were based on: (1) no purchase power (2) power for all paper-making equipment as well as box shops and all other departments generated at the mill (3) production output per day of 303 tons from the three largest of the five paper machines (4) 84% boiler efficiency (5) steam at 600 psig, 750 F at the turbine throttle, 175-psi extraction, 30-psi backpressure.

This comparison shows a decrease of 44.3% in Btu per lb needed for paper. Eliminating condensing turbines, plus cutting down other heat losses reduced total steam needed. This saving in steam, in turn, reduced boiler-room losses by almost 60%, table, p 112.

When it came time to select firing equipment still more savings were possible. The new boiler was to be designed for a range of coals. It had to handle fuels that were economical and readily available. Fuel now used runs 11,500 Btu per lb with a higher moisture and ash content than the old boilers could possibly handle. Result has been a less expensive coal that reduces over-all fuel costs (including



2 Spreader stokers solved firing-equipment problem requiring high flexibility in (1) range of fuels handled and (2) load swings as well as low-maintenance costs



3 Automatic coal scales, above, supply and record flow of coal to the hopper

Survey Pays

savings from conden-ser elimination, revamped mill-drives, etc, above text) some 45 to 50% below previous figures.

Turbine Selection. But before we discuss the new boiler let's look at the turbine selected. We wanted it to be noncondensing. So its size and throttle requirements fixed the new boilers' operating pressure level. Further, the basis for much of the savings indicated by the survey was a good heat balance, Fig. 7.

We determined the turbine size by (1) taking the electrical load at the time of the survey (2) adding new load of motor drives that would replace engine drives (3) figuring in the extra load from proposed new electrical equipment. The total reached 9000 kw. Before all changeovers take place the electric load, of course, will run much less. And this will be the case for some time to come.

With this background, we picked a generator of 10,714-kva capacity and a turbine to drive it that could develop enough power to generate 9375 kw when the power factor imposed on the generator was 87.5%. System power factor runs high because of the number of synchronous motors driving the Jordans. Our choice was a turbine with a nominal rating of 7500 kw at 0.7 pf.

An extraction point at 175 psig supplies steam to drive the old engines still in use, and to meet the needs of corrugators, straw cookers and other services. In addition, an uncontrolled extraction point operates at about 75 psig. Steam from here heats boiler feedwater under two conditions: (1) when heat balance can be improved (2) at low boiler loads when increased feedwater temperature can reduce heat removal from flue gas to a point where gas leaves the stack high enough above dewpoint temperature to prevent condensation and corrosion.

Backpressure was fixed at 40 psig since this is close to safe operating limits for the paper-machine dryers. At present, steam for this service comes off at 30 psig.

To deliver enough steam at the required pressures and quantities, above, to process and plant, and yet generate the proposed final electrical load we chose throttle conditions of 600 psig and 750 F.

Boiler Equipment. For our boiler we went to a 180,000-lb-per-hr 4-drum 700-psig design having a 54-in.-dia steam drum, and 19,500 sq ft of heating surface including waterwalls.

Certain outside factors influenced boiler-room construction. One was possible delay from a scarcity of both bricks and bricklayers. So we decided on a semi-outdoor boiler installation. Such installations had been made and operated successfully in Utah, Nebraska and Colorado, with climates similar to ours.

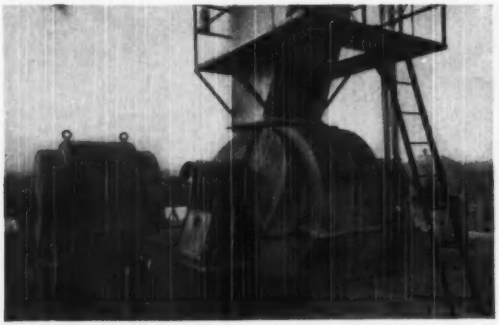
Earlier we had thought of a completely new building for the power plant. But the existing boiler house was centrally located so costs for steam and electrical lines could be kept low. It was well constructed and adequate for housing some of the new equipment. There was space enough at the south end of the boiler room for a firing aisle inside the building to serve the semi-outdoor new boiler. A small lean-to at the side of this boiler allows the fireman to check firebed conditions through side observation doors without going outdoors.

The old coal-handling system had a track running the full length of the boiler house through a bay 20 feet wide. We shifted all coal handling outside and used the bay, Fig. 1, for turbine, office, laboratory, washroom and boiler feed pumps.

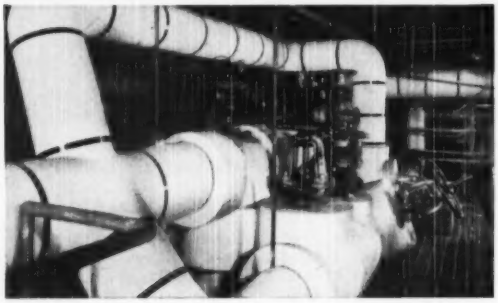
With this arrangement of new and old equipment side by side, the old can be easily used as standby. The basement is entirely enclosed. It houses the forced-draft fan, sifting hoppers under the boilers, and the ash hopper. In the future a building can be put up around the boiler because the foundation has been designed strong enough for it.

All steam and water piping and soot-blower heads that go outdoors have copper tubing spiraled around them. Steam continuously flows through the tubing during freezing weather and its condensate discharges through traps in the enclosed basement.

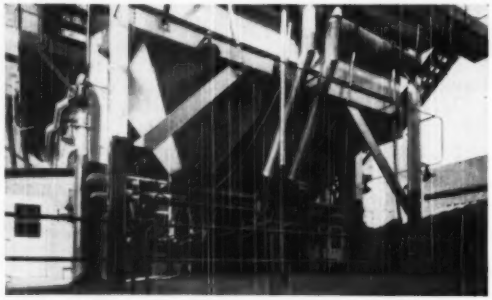
Firing Equipment. As we mentioned earlier, p 110, the new boiler was designed for a range of fuel. Firing equipment, of course, had to be able to handle these fuels. The choice lay between a spreader moving-grate stoker and pulverized coal—both have firing



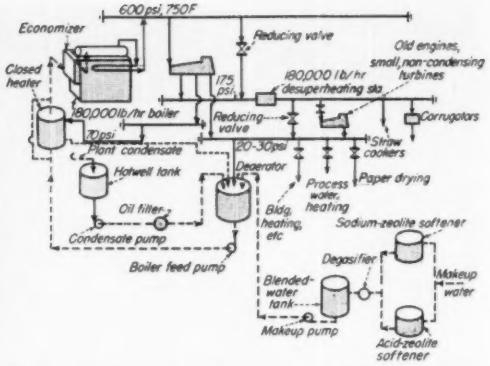
4 Induced-draft fan mounted outdoors has dual drive; one, normal service, the other at half speed for light loads



5 A heavy process and auxiliary-engine load at 150 psi require controlled pressure reducing and desuperheating



6 Complete flyash reinjection system coupled with mechanical dust collector gives low carbon loss, runs nuisance-free



7 Flow diagram, above, shows major power-plant equipment and traces the different pressure levels of the steam supply

COMPARISON OF COSTS IN BTU

Item	Btu per pound of paper made: Old operation	New operation	Decrease in Btu needed	Equivalent lb of 600-psi 750-F steam per hr based on new operation
Paper drying	3290	3290	0	71,100
Heating process water	1260	1260	0	27,200
Heating boiler feed water	815	427	388	9250
Turbine steam condensing water to sewer	2660	eliminated	2660	0
Corrugators	303	303	0	6550
Heat equivalent for mech & elec power	1160	885	275	19,150
Misc and exhausted to atmosphere	727	50	677	1080
Straw cookers	221	221	0	4760
Building heating and miscellaneous	402	402	0	8680
Boiler-room losses	3780	1287	2493	
Total Btu supplied in coal per pound of paper	14,618	8125	6493	
Steam per hour				147,770
Equivalent pounds of 13,600 Btu coal per pound of paper	1.075	.598	.477	

capacities equal to the job of furnishing 210,000 lb per hr of steam at load peak. Here is how these two firing methods shaped up:

All operators at plants we visited that used spreader stokers liked them very much. We knew these facts: (1) The spreader stoker readily burns almost any coal, particularly low-grade ones, like those from Indiana and Illinois and strip-mine coal from Ohio. (2) It has low power requirements. (3) Clinkering is small, both in amount and as a problem where stoker and furnace are properly designed. (4) Maintenance costs are low. (5) Space around the boiler is comparatively free of equipment. (6) Main ash handles easily. (7) Stoker operates well with preheated air up to 300 F. (8) It is able to meet fairly rapid load changes. (9) Furnace explosions rarely occur.

On the other hand, stokers suffer from occasional shear-pin failures. The spreader stoker actually selected, Fig. 2, has each feeder individually driven through a clutch. So if a feeder goes out of service for a short time the remaining five feeders continue to supply coal. Feeder capacity is greater than the required maximum and it seems likely that five feeders could carry even a maximum load. In addition to shear-pin failure, flyash from spreaders can be a problem. But the proper selection of a dust collector combined with cinder reinjection, Fig. 6, can solve this difficulty. So far it seems to have done the job at River Raisin.

Pulverized Coal. Firing a boiler with pulverized coal offered several advantages. Principal ones were the fine sensitivity to rapidly fluctuating steam loads; an ability to use a high-temperature preheated air so full use could be

PRINCIPAL POWER PLANT EQUIPMENT

River Raisin Paper Company Addition, Monroe, Michigan

STEAM-GENERATING EQUIPMENT:

Boiler, 1 ..... Wickes Boiler Co
180,000-lb-per-hr, 700-psig, 750-F, 4-drum, Stirling-type
Superheater, 1 ..... Foster Wheeler Co
Pendant bare-tube-type, 3790 sq ft, no bypass
Economizer, 1 ..... Foster Wheeler Co
16,720 sq ft of extended surface
Stoker, 1, continuous ash discharge ..... Detroit Stoker Co
Six feeder, 370 sq ft effective grate area
Dust collector, 1, mechanical, 97% efficiency ..... Aerotec Corp
Induced-draft fan, 1 ..... American Blower Corp
116,700 cfm at 400 F, 12.2-in. static pressure at 885 rpm
Induced-draft fan drive, 1 ..... Elliott Co
350 hp, 4800 volts, 900 rpm, splashproof squirrel cage
Induced-draft-fan drive, 1 ..... Howell Electric Motor Co
50 hp, 450 rpm, splash proof, motors electrically interlocked
Forced-draft fan, 1 ..... American Blower Corp
66,900 cfm at 80 F, 4.5-in. static pressure, 860 rpm driven by 75-hp Louis Allis motor
Boiler setting ..... M H Detrick Co
Steel supported, steel cased
Soot blowers, retracting, fixed ..... Diamond Power Specialty Corp
Combustion control and boiler instruments ..... Bailey Meter Co

ASH- AND COAL-HANDLING EQUIPMENT:

Flyash reinjection ..... Detroit Stoker Co
Ash-hopper gates ..... Allen-Sherman-Hoff Co
Most of old ash-sluicing system used
Coal handling, capacity 70 tons per hr ..... Stephens Adamson Mfg Co
Bunker, 1, capacity 300 tons ..... Stephens Adamson Mfg Co
Coal scales, 2, automatic ..... Stock Engineering Co
Coal-car thawing ..... Hauck Mfg Co

FEEDWATER SYSTEM:

Feedwater regulator, 1, Copes ..... Northern Equipment Co
Spray-type deaerating heater, 1 ..... The Permutit Co
360,000 lb per hr, 40 psig, 89,600 lb water storage
Closed pressure heater, 1 ..... The Griscom-Russell Co
Rating 210,000 lb per hr from 259 to 300 F with 75-psig steam
Feedwater softeners ..... The Permutit Co
Sodium-acid softening system, capacity 80,000 lb per hr
Boiler feed pumps, 2 ..... DeLaval Steam Turbine Co
Chrome-steel construction; one Elliott motor drive; one DeLaval turbine drive; 225,000 lb per hr
Chemical-feed pumps, 2 ..... Proportioneers, Inc
One simplex for sodium sulphite; one duplex for phosphate

TURBINE-GENERATOR AND SWITCHGEAR:

Turbine, 1 ..... Westinghouse Electric Corp
3600 rpm, inlet steam 600 psig, 750 F, exhaust 40 psig, 175-psig controlled extraction, 75-psig uncontrolled
Generator, 1 ..... Westinghouse Electric Corp
7500 kw, 0.7 pf, 10,714 kva, 3 phase, 60 cycle, 4800 v
Main switchgear ..... Westinghouse Electric Corp
Transformer, station power ..... Ruhlman Electric Co
Motor-control center ..... Square D Co
480-volt air circuit breakers and starters
Turbine instruments ..... Bailey Meter Co, Hays Corp

VALVES:

Valves, miscellaneous ..... Manning, Maxwell & Moore, Inc; Edward Valves, Inc; Crane Co; Lunkenheimer Co; Cochrane Corp; Atwood & Morrill Co; R-S Products Corp
Turbine crane ..... Manning, Maxwell & Moore, Inc
Hand operated, capacity 20 tons
Reducing valves and desuperheater ..... Northern Equipment Co
One reducing valve, 180,000 lb per hr, 600 to 175 psig; one reducing valve, 80,000 lb per hr, 175 to 40 psig; one desuperheater, 180,000 lb per hr, 750 to 390 F, spray type
Passenger elevator, 1 ..... Detroit Elevator Co
1200-lb capacity, 100 fpm, pushbutton, automatic

CONTRACTORS:

Heat insulation ..... The Philip Carey Manufacturing Co
Building construction ..... Kriegshoff-Lenawee Co
Electrical ..... Jack Frost Co
Machinery erection ..... Lansing Engineering and Maintenance
Piping ..... Johnson Larsen & Co

CONSULTING ENGINEERS ..... Cummins & Barnard, Inc

made of preheater surface; an operating characteristic that permits consistent service close to design efficiency; an absence of any moving parts in the furnace zone.

But the disadvantages for River Raisin operation outweighed the advantages. We felt fuel selection was more limited; maintenance costs ran too high; space around the boilers was too cramped for pulverizers and auxiliaries; power requirements for these auxiliaries were greater than the stoker needs; explosion hazards were higher; a separate firing system would be needed for very light loads; in any event a lighting-off system using oil or gas should be put in; flyash from pulverized-fired furnaces was finer and harder to recover than that from spreader stokers, and its collection for best results meant an electrostatic precipitator.

So we decided on a spreader stoker, Fig. 2, with a moving grate of 370 sq ft effective surface. A complete flyash-reinjection system, Fig. 6, returns ash from hoppers underneath the rear of the boiler, the economizer and the dust collector. This collector, a mechanical one of tubular design, has a collection efficiency of 95% when handling dust with maximum of 10% in the range of sizes between 0 and 10 microns and averaging 5 microns.

To date equipment has met all conditions in excellent fashion. In fact during the October 1949 coal strike we fired any coal we could find. Some of it averaged about 10,400 Btu per lb, was very dirty and, at times, quite wet. Yet the boiler carried an average load of 140,000 lb per hr (the plant load at the time) at an efficiency of about 83% when feedwater to the economizer ran 270 F. The equipment table, just above, shows most of the new power-plant equipment.

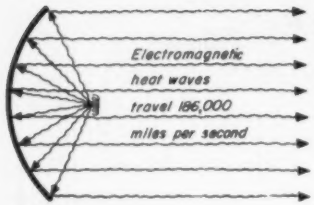
The forced-draft fan in the basement draws its air from there through dampened inlet louvers under the operation of a combustion control system.

The induced-draft fan, Fig. 4, mounts on a platform above the boiler and dust collector. It discharges into the steel stack through an Evase section. Main drive consists of a 350-hp 4800-v motor designed for outdoor operation. A 50-hp motor serves for half-speed duty during start-up time and light loads under 100,000 lb per hr.

Pressure Reducing Station. Because a number of engines were still operating at low pressures and temperatures a special pressure-reducing and spray-type desuperheating station, Fig. 5, was put in. It can reduce up to 180,000 lb per hr of 600-psi 750-F steam to 175 psig, 380 F. Operation is fully automatic with power-operated valve that closes when temperature in the outlet side of the desuperheater drops below a set point. An alarm sounds ahead of the automatic closing.

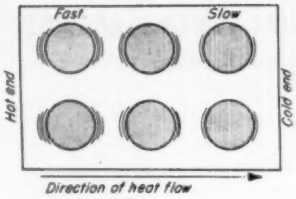
A number of engines still must operate even at low pressures and temperatures so control at the pressure-reducing station received top attention. A recording control capable of manual adjustment went in. Other equipment is of a standardizing-action design so that discharge side holds a constant temperature and pressure regardless of steam flow. All valves can be manually operated even if air pressure fails.

Success of the new installation reflects favorably on the cooperation of both owner and consultant's staff. The owner's staff was headed up by Charles L Wood, president and general manager, A J Goetz, vice-president in charge of purchases, H Lamb, plant superintendent, M L Knack, technical director, Gerald Hage, chief power engineer, Clark Gallagher, maintenance engineer, Ray Traver, boiler-plant supervisor. Representing the consultants—Cummins & Barnard, Ann Arbor—were H N Barnard in charge of design; A A Cummins, report and preliminary design; H L Andersen, electrical engineer; R G Ganong, in charge of construction; A Haven, structural designer; C D Bassett, mechanical engineer in charge of piping.



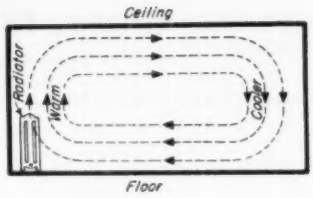
RADIATION

Radiant heat waves, exactly like radio waves but much shorter, travel through air or vacuum with the speed of light



CONDUCTION

Heat flows through a solid by conduction only. Fast-moving molecules at hot end speed cold ones by bumping process



CONVECTION

Hot air is lighter than cold, so air heated by radiator at left rises, then cools and falls again to floor

Insulation Handbook: Part I—

This handbook, to be published in six parts, starts with the fundamentals of heat flow. Later articles answer practical questions—What kind of heat insulation meets specified conditions? How thick? What saving? How applied? How protected?

By **PHILIP SWAIN**, *Editor*

► THIS SERIES serves as a condensed handbook of heat insulation for power engineers. It will help them save heat units and dollars by the intelligent selection and application of heat insulation to the hot and cold surfaces of piping, tanks and many other types of power-service equipment. Before turning to this practical side, here are a few scientific fundamentals.

Heat Flow. Throughout these articles we shall measure heat in Btu, but remember that heat can be measured in other units as well.

For example, one kilowatt-hour is 3413 Btu. Therefore, one watt hour is 3.4 Btu. Thus any insulation completely surrounding a 40-watt electric lamp bulb will necessarily transmit 3.4 x 40 = 136 Btu per hour after the lamp and the insulation have warmed up to a steady state.

And this will hold true regardless of the thickness or efficiency of the insulation, since the lamp is a constant-rate source of energy.

Heat Travels Through Vacuum. Heat can traverse a vacuum, as from the sun to the earth, in one way only — by electromagnetic radiation, exactly like radio waves and light waves in kind, except that the waves are much shorter than the shortest radio waves. All speed through space at the rate of 186,000 miles per sec.

This radiant heat will pass through air, as it will through a vacuum, but it has no need for the air. You might say radiant heat flows *in spite of the air* and loses something through absorption by the air.

Heat Flow Through Solids. Just as heat can flow in one way only (by radiation) through a vacuum, so also there is only one way for it to flow through a solid—that is, by conduction. In any solid, at any temperature above absolute zero (−460 F), the molecules are in constant vibration. The higher the temperature, the faster they vibrate. Each molecule bounces back and forth within a limited range of its normal position, as though it were fastened to a stake by a rubber cord.

Each moving molecule is constantly bumping into its neighbors. Naturally, when fast-moving molecules bump into slow-moving ones, the fast are slowed down and the slow are speeded up, on the average. That is how heat flows by conduction from the hotter parts of the solid to the cooler parts. Thus temperatures tend to equalize throughout the solid object unless heat is constantly supplied to the hot points, and taken away from the cold points.

Convection. Convection, the third way to transmit heat, commonly occurs in liquids, gases and vapors, but never in solids.

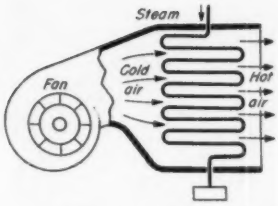
In convection the liquid or gas (or vapor) actually moves from the hot surface, where the heat enters, to the cold surface where it is removed. Thus the heat is carried bodily from one point to another.

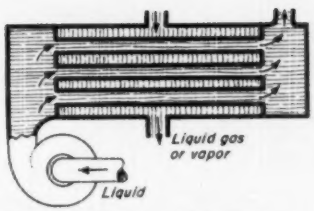
Of course, convection always involves some conduction also, at the points where the heat is "loaded" into and "unloaded" from the moving fluid.

This convection movement may be produced "naturally" by temperature differences, or by a pump or fan. The air circulation set up by a radiator in a room (see sketch above) is a common example of natural circulation, as is the circulation of water heated by a submerged steam coil. In both cases, the heated fluid expands and then rises because it is lighter than the surrounding air or water. Later it cools, becomes heavier and falls, thereby completing the convection circuit.

Much higher fluid-flow rates are obtainable with forced circulation by fans or pumps, and much is gained by this increased flow. In fact, the flow of heat increases much faster than the flow of gas or water. Not only is more fluid circulated, but its high velocity scrubs away the surface film, and thereby reduces the resistance.

That is why fans are widely used in industry to blow air over heating coils, and pumps to push water or other





FORCED CONVECTION SPEEDS UP HEAT TRANSFER

Forced convection, by fans or by pumps, scrubs away much of the insulating fluid film that retards the flow of heat, thereby greatly increasing the heat-transfer capacity of steam-coil air heaters, liquid heat exchangers and similar equipment

How Heat Flows

liquids at high speeds through heat exchangers. In this way a given investment in heating surface can transmit far more per hour than would otherwise be possible.

Most of the practical applications of heat transfer and heat insulation involve a combination of two or three of these methods of heat moving—conduction, convection and radiation.

The role of true radiation in heat transmission is often misunderstood. It may be important, or it may be unimportant, depending largely on the temperature levels involved, because the heat radiated from the surface varies as the fourth power of the absolute temperature. The rate at which these fourth powers build up is truly astonishing (see sketches at right).

There is no such simple mathematical rule for heat transmitted by convection. True, figuring heat delivery would be easy if we knew not only the rate of air circulation but also its temperature leaving and returning for a new load of heat. In that case heat moved would be the weight of air moved, multiplied by the temperature difference and by the specific heat of air.

The practical difficulty is that of predicting just how much air will flow (in the case of natural circulation), and (in all cases) what its initial and final temperatures will be.

The field of convection heat transfer is so full of theory and guesswork that the average practical man is often forced to solve his heat-transfer problems by cut and try. He adds or subtracts heating surfaces until he obtains the desired heat-transfer rate.

But we must not jump from this fact to the unwarranted conclusion that it is difficult to make a reasonably close estimate of the heat loss from insulated surfaces. The opposite is true. The reason is that film resistance on the steam and air sides of a metal plate, as well as the resistance of the plate itself, becomes less important when the surface is insulated.

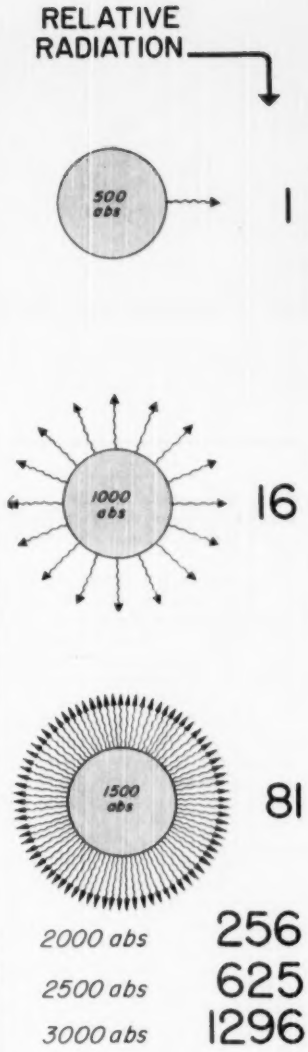
For example, the heat loss from a bare heated surface may vary considerably, depending on the position, and on the nature of the surrounding air currents because both have a big effect on the outside air film. Yet as soon as the insulation is applied, air currents and position become relatively unimportant (see final illustration on p 116). That is why the heat loss through insulated surfaces can be accurately figured from the known properties of the insulation.

Conduction. In practically all cases where insulation is applied in substantial thicknesses, conduction through the insulation itself is the controlling factor in heat transmission.

Here, fortunately, the theory is simple. Consider (sketch, top p 116) a square slab of a given insulating material, 1 ft square and 1 in. thick. Assume one face is one degree hotter than the other.

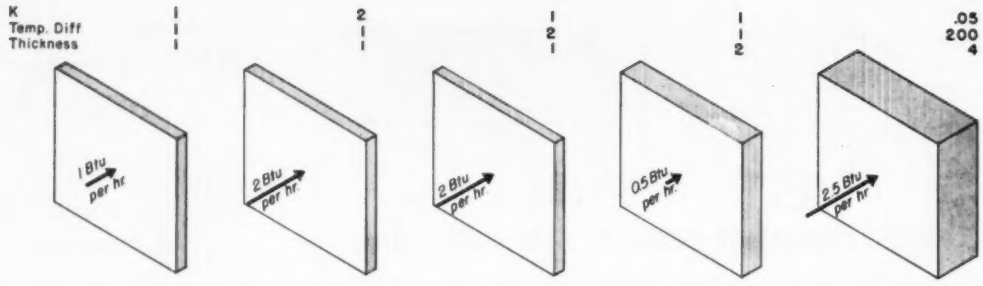
Then heat will flow from the "hot" face to the "cold" face, and its amount, in Btu per hour, will be the so-called K factor, or *conductivity*.

Once the K factor is known for a given material, it is easy to figure how much heat will be transmitted through any thickness of it over any area and with any temperature difference. Total heat flow will be in direct proportion to



RADIATION SKYROCKETS AS FOURTH POWER OF ABSOLUTE TEMPERATURE

For example, take 500 abs (40 F) as standard of comparison. If you double temperature to 1000 abs, radiation jumps to $2 \times 2 \times 2 \times 2 = 16$ times. At triple temperature (1500 abs) radiation is $3 \times 3 \times 3 \times 3 = 81$ times that at 500 abs, and so on, as indicated above. That is why radiant heat is far more important at the higher temperatures



K × TEMPERATURE DIFFERENCE ÷ THICKNESS = BTU PER SQUARE FOOT PER HOUR

K, conductivity, is Btu per hour that will flow through a slab 1 ft square and 1 in. thick when one face is 1 deg F hotter than the other. *K* varies from as low as 0.4 for good insulators to values hundreds of times greater for some metals. Note that heat flow doubles if you double either *K* or temperature difference, but is cut in half if thickness doubles

the *K* factor, to the area and the temperature difference, and in inverse proportion to the thickness of the insulating material.

Thus, the heat flow through one square foot of flat insulation will be the product of the *K* factor by the area in square feet, by the temperature difference between the surfaces and the insulation, divided by the thickness of the insulation in inches.

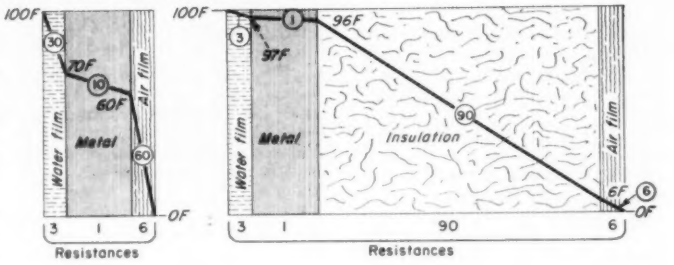
This does not hold for pipe insulation because the circumference increases as the insulation builds out from the pipe. This important exception will be covered in future articles. Assume that all computations in this article apply to flat surfaces only.

It is important to remember that the temperature difference through the insulation is always somewhat less than total temperature drop. For example, where insulation is applied to a steam-heated metal surface there are small temperature drops at the inner surface film, through the metal, and from the surface of the insulation through an air film to the surrounding air. But most of the total temperature drop from steam to air will occur in the insulation itself.

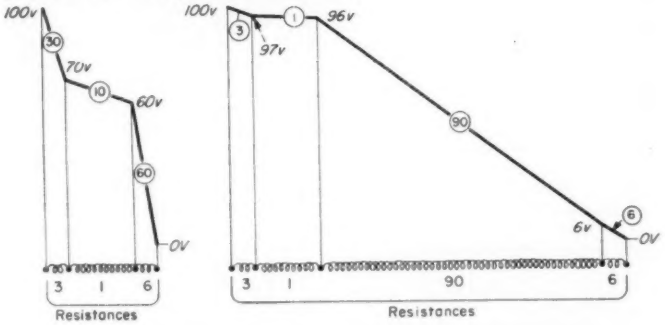
In all such cases the heat flows through a series of resistances, and the drop of temperature through any particular resistance in this series is in exact proportion to its resistance. Thus, when heat flows through a high resistance in series with a low, most of the temperature drop will occur in the high resistance.

The analogy with electricity is exact, as illustrated at bottom of page. Caption shows why film resistances, wind action, etc, are less important for insulated surface than for bare surface.

Heat flow through resistances in series



Electrical flow through resistances in series

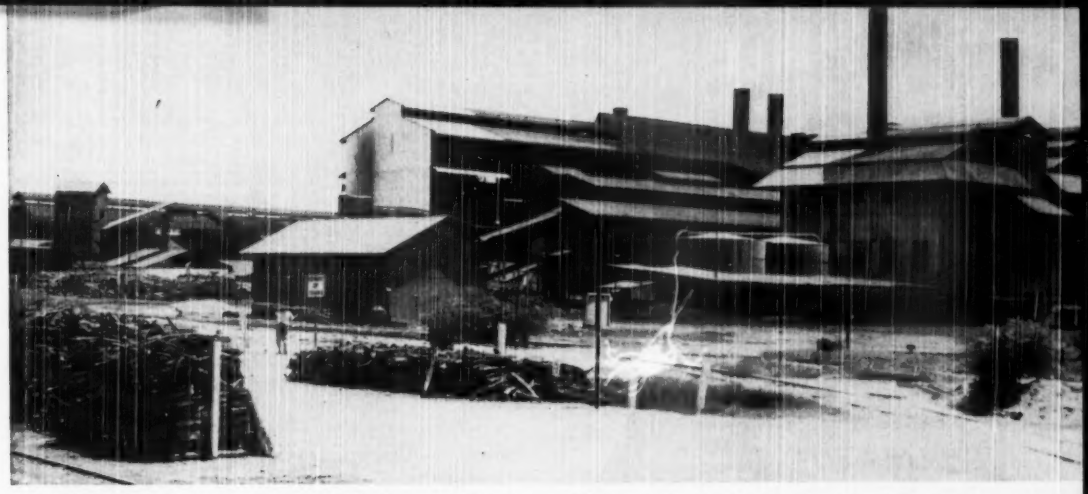


COMPARING THE FLOW OF HEAT AND ELECTRICITY

The resistance of a block 1 ft square = thickness ÷ *K*. Thus, if *K* is 0.52, and thickness 4 in., resistance is 4 ÷ 0.5 = 8. This means it will take a temperature difference of 8 degrees to push one Btu per hour through the slab.

For either electricity or heat, add the resistances in series to get the total resistance of the setup. Then flow (Btu per hour or amperes) will equal potential difference (degrees or volts) divided by total resistance.

The potential drop through any resistance in the series will be the same percentage of total potential difference as the individual resistance is of the total. Applying this rule, note how insulating the bare surface (top right) makes film and metal resistances relatively much less important.



COAL SHORTAGES led copper properties in Northern Rhodesia to burn African woods. Here's what they learned about . . .

Wood Firing in Pulverized-Coal Units

The authors* tried several grate constructions, solved problems of charcoal burning and slag removal. Their experience may help you if you run into a similar emergency

► To Northern Rhodesia, one of the world's important copper-producing countries, the end of the war brought shortages of rolling stock and other railroad difficulties. This, in turn, meant shortages of coal from Wankie, Southern Rhodesia, and problems for the four large mining companies whose modern steam power plants burn it. In the emergency, they turned to native African woods to eke out fuel supply.

Since temporary conversion of pulverized-coal furnaces for wood burning presents unusual problems, a description of experiences at two of these companies — Rhokana Corp, Ltd, and Nchanga Consolidated Copper Mines, Ltd—may prove of interest and value.

Type of Wood. The copper belt of Northern Rhodesia is well wooded with trees common to vast areas of Central Africa. Naturalists know them as *brachystegia* and *isoberlinia*. The wood is hard, heavy and, in its living state, remarkably resistant to the fires that sweep the country each year in the dry season. Natives set these fires deliberately, to burn grass and undergrowth as an aid to hunting.

As received, the wood contains 25 to 40% moisture and about 2.2% ash on the dry basis. Heating value runs about 5800 Btu per lb, dry. An analysis of a representative ash sample is given in the table on p 164. Contractors employing large gangs of native laborers delivered wood by truck to the power stations. It came in 4-ft lengths, varying in diameter from 3 to 10 in.

Rhokana Experience. Five direct-fired and eight waste-heat boilers supply steam at Rhokana Corp. Four of the direct-fired units are International Combustion boilers, rated at 40,000 lb per hr and 360 psi. The fifth direct-fired unit, of 80,000-lb-per-hr capacity, will ultimately run on waste-heat from a future reverberatory installation. The waste-heat boilers, also International Combustion, receive flue gas from four copper reverberatory furnaces. They are good for 80,000 lb per hr.

In addition, the refinery furnace is equipped with a Babcock & Wilcox waste-heat boiler having a capacity of 12,000 lb per hr at 160 psi. Process steam for the refinery tank house comes from three direct-fired Babcock & Wilcox boilers at 160 psi. One is rated at 18,000 lb per hr, and the other two at 3500 each.

Direct-fired boilers and reverberatory and refinery furnaces were fired with pulverized Wankie coal. This is a good grade of bituminous, averaging 13,300 Btu per lb, with 8-10% ash.

At Rhokana, we cut the wood into 2-ft lengths. An inclined belt carried it to the firing boxes of two boilers. Then it was thrown on the fuel bed by hand. Wood was fed for about 12 minutes out of every 20. It was necessary to remove the pulverized-coal burner since this was the only entry into the combustion chamber. The other three sides have watercooled walls.

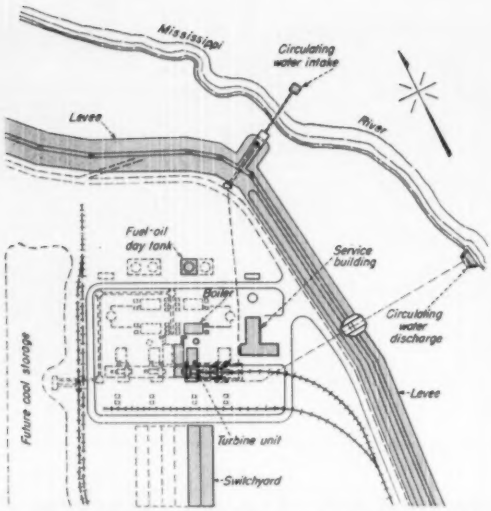
Grate Construction. In the first boiler converted, cast-iron grate bars were installed above the ash-screen tubes. The grate sloped from front to back at an angle of 10 deg. Because fusible slag formed from the wood ash, we had to test a number of grate-bar spacings. After trying widths from 0.5 to 1.5 in., a one-inch spacing was finally adopted. When we were able to dispose of all charcoal, we reverted to a 1.5-in. spacing.

In the second boiler, steel rails were used in place of cast-iron grate bars. The air space between the rails, originally set at 1.5 in., was later closed to 0.75 in. This grate had an angle of 17 deg.

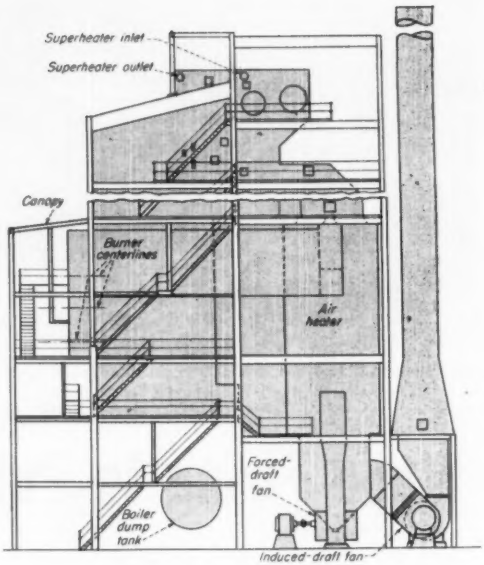
In the first converted boiler, a center firing chute was installed. In the second, two chutes with a tipping device proved unsuccessful. The low-grate angle prevented the wood from sliding to the back of the grate and keeping

(*Continued on page* 162)

*R S Young, chief research chemist, Rhokana Corp, Ltd and Nchanga Consolidated Copper Mines, Ltd; J S MacDonald, power-plant supt, Rhokana Corp, Ltd; and W B Douglas, asst resident engineer, Nchanga Consolidated Copper Mines, Ltd.



1 Plan of ultimate station layout shows arrangement of four single-boiler-turbine units protected from floods by levee



2 Single 625,000-lb-per-hr gas-fired steam generator for first unit stands completely outdoors; canopy over burners

NINEMILE POINT: New Outdoor Plant

One of three similar unit-type steam-electric plants, whose concurrent design helps lower first cost. River levee imposes problem in handling cooling water. Plant design calls for minimum housing. Twin-shell condenser reduces headroom needed

By **LOUIS ELLIOTT**, *Consulting Mechanical Engineer*
Ebasco Services Incorporated

► LOUISIANA POWER & LIGHT CO. serves two portions of the state. One is in the northern half, while the other is in the southern area, some little distance north of New Orleans. These two sections are connected by 110-kv lines, which form part of the network of the Arkansas-Louisiana-Mississippi-New Orleans or Middle-South System. The 150-mw Sterlington steam-electric station on the Ouachita River supplies most of the energy to the northern region.

Until recently the Louisiana P & L load in the area across the river from New Orleans was carried largely by plants of New Orleans Public Service, Inc. By 1952 this rapidly growing load will be about 65 mw. Total Louisiana P & L load in the southern area will grow to about 100 mw by that time.

To safeguard this important load the steam-electric Ninemile Point Station was projected for erection on the Mississippi's right bank opposite New Orleans. In addition, there still will be the 13-kv tie with New Orleans and the 110-kv tie with the Middle-South System. This new plant will have one 60,000/66,000-kw 1250-psig 900-F preferred-standard turbine-generator, supplied by a 625,000-lb-per-hr steam generator burning natural gas with oil as reserve. The plant will primarily deliver to the 110-kv transmission system.

Joint Plant Design. Ninemile Point Station gets its name from the point on which it stands at a bend in the Mississippi. The plant is one of three under design by Ebasco Services Inc for Lousiana Power & Light, Mississippi Power & Light, and Arkansas Power & Light. Stations of the first two companies will each have one 66-mw turbine, and the third, two 66-mw units. All stations are planned for four units ultimately.

These three plants have boilers and turbines of identical size using the same steam conditions. All are designed for gas firing. By agreement of the three operating companies the stations are laid out as nearly identical as practicable. This is particularly true within an area surrounded by a roadway loop containing major plant features except electrical switchyard and condensing-water works. In all three plants a concrete slab placed near ground level obviates substructures. When practicable, common drawings will be used to cover all three plants. As a result the participating companies will realize savings in time and expense for engineering and materials.

Plant Site. During the fall of 1948 a search was made for the best site for Ninemile Point Station. The most promising locations lay along the banks of the Mississippi River—the obvious source of condensing water. Most suit-

able conditions were found on Ninemile Point, a short distance below the Huey P. Long Bridge and about opposite the upstream boundary of New Orleans.

The material making up this point was apparently laid down by the river. It offered better soil and foundation conditions than the region downstream from New Orleans.

Practically all land in this vicinity lies at an elevation well below maximum flood level in the Mississippi. Levees protect this area. The grade at Ninemile Point is between 10 and 15 ft above the Mean Gulf Level. The latter is also approximately the elevation of low water in the Mississippi River in this vicinity.

The location selected is also favorable for connecting into the electrical transmission system, and has other advantages.

Fig. 1 shows layout of the plant site. The levee stands some distance back from the low-water line of the river. A roadway loop encloses the major portion of the plant. A railway spur serves the main station, step-up transformers and electrical switchyard. Space for future oil tank and coal storage is in the area below that shown in Fig. 1. The station stands on the downstream side of Ninemile Point.

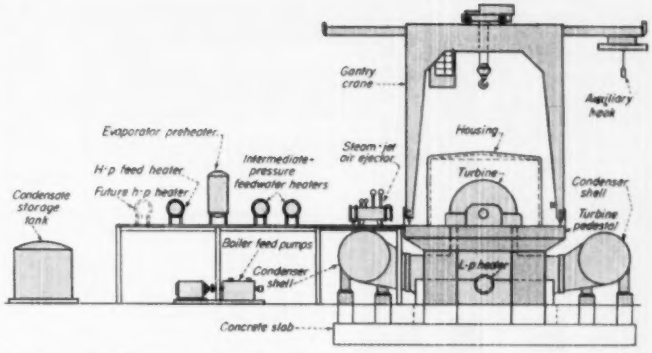
CONDENSING-WATER WORKS

Design calls for a simple form of intake structure provided with grills. It is built a short distance out into the river from the low-water line. A single steel pipe serving one turbine runs from this structure to a pump chamber a short distance outside the levee. The pump pit is laid out for four circulators to serve two turbine units. Each pump is specified for 55-cfs capacity at 45-ft. head. Two pumps are installed initially, each supplying a steel pipeline running up over the top of the levee.

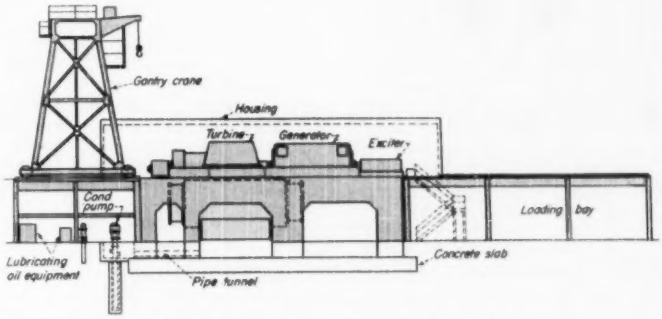
River authorities ruled that neither pipe nor tunnel may pierce the levee in this vicinity. For the circulating-water discharge, steel pipes are routed over the levee top and into a seal well on the river side. Distance from the levee to the low-water line is relatively short at the intake, but the width of batture at point of discharge is greater.

STATION ARRANGEMENT

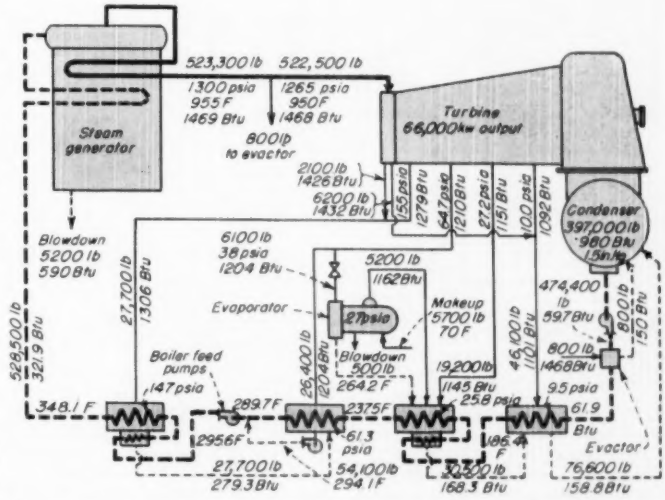
Only enclosed areas in the plant are (1) central boiler-turbine-electric control room (2) battery room and (3) switchgear room. The boiler firing aisle will have a canopy. The steel turbine housing will have fixed sides and roof hatches. The reinforced-concrete turbine pedestal will maintain the turbine base 16 ft above the bottom slab. A 30-ton gantry crane with a 10-ton



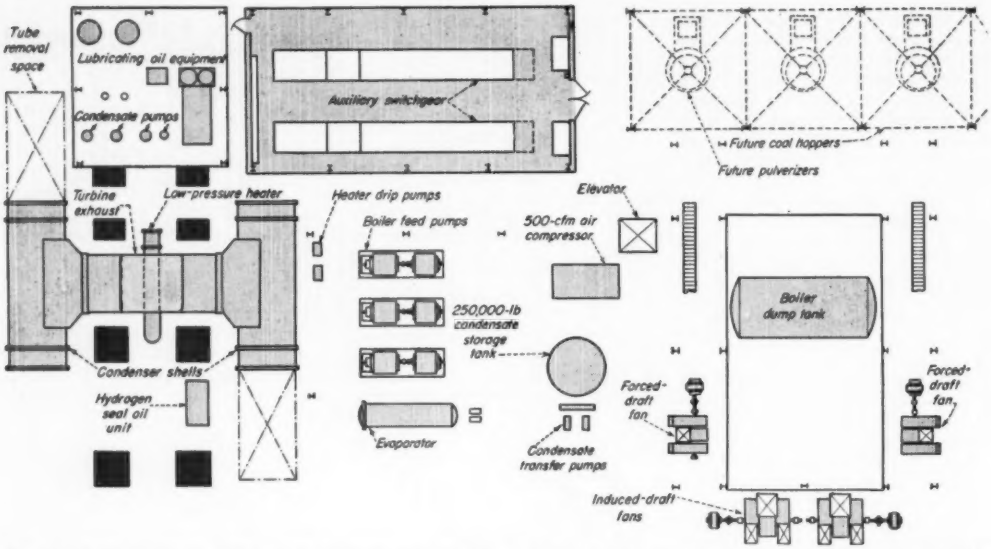
3 Twin-shell 55,000-sq-ft condenser serves 60,000-kw preferred-standard turbine. Steel housing with roof hatches over turbine protects unit from rainy weather



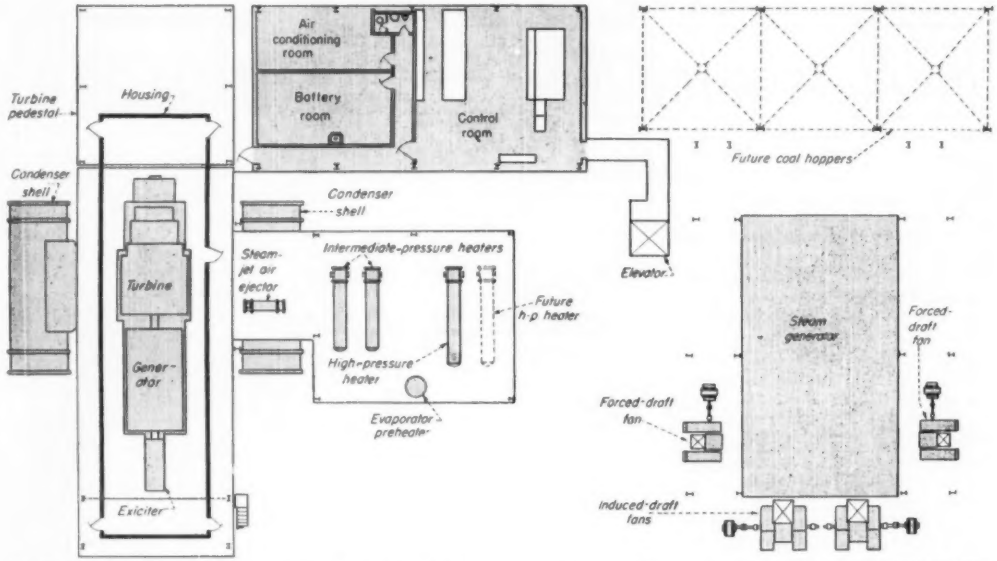
4 Gantry crane of 30-ton capacity with 10-ton auxiliary hook serves turbine and adjacent equipment. Crane runs on rails to loading area at right, off pedestal



5 At maximum turbine capability of 66,000 kw, net output equals 62,000 kw. At 84% steam-generator efficiency, net station heat rate is 11,550 Btu per kwhr



6 Most of equipment on ground level is covered by operating decks and platforms above, see Fig. 7. Auxiliary switchgear and transformers are completely housed. Note twin-shell condenser arrangement on each side of turbine-exhaust nozzle



7 Turbine operating level has heaters supported on platform adjacent to unit. Battery room, air-conditioning room and central-control room are on second floor of building housing auxiliary switchgear below. Note future coal provisions

auxiliary hook serves the turbine and other equipment. The crane runs on rails resting on the turbine pedestal.

A separate, single-story building will house machine shop, storeroom, offices, lockers and toilet facilities.

Fig. 2, 3, 4, 6 and 7 show station elevation and plan views. Reduction of housing to a minimum is apparent. No estimates have been made during the recent past for conventional, fully enclosed plants of similar mechanical layout. Hence the saving in dollars by utilizing this outdoor type of construction cannot be definitely stated. From approximate comparisons in the past, the saving for a single-unit station of this type is figured at about $700,000, as compared with a conventional fully housed design.

Boiler Plant. The single steam gen-

erator has continuous rating of 625,000 lb per hr and an 8-hr rating of 650,000 lb per hr. Steam discharging from superheater outlet will be at 1350 psig and 955 F. A flue-gas bypass damper in the boiler will control superheat temperature. The furnace will burn natural gas as the main fuel at a heat release of 27,100 Btu per hr per cu ft. A tank farm nearby will supply reserve oil.

The 3-drum boiler will also have an economizer and a tubular air heater. The automatic combustion-control system will use a low-pressure air-loading arrangement actuating electric power units at the boiler control points. Two forced-draft and two induced-draft fans serve the single boiler.

Turbine-Generator. The preferred standard 60,000/66,000-kw 1250-psig 950-F turbine exhausts into a 55,000-sq-ft surface condenser. This condenser consists of two shells taking the exhaust steam through a breeches piece under the turbine exhaust nozzle. Condenser will remove 430,000,000 Btu per hr from the steam with about 2.5-in.-Hg-abs pressure when inlet-water temperature equals 85 F.

The hydrogen-cooled 3600-rpm generator will be able to develop 69,000 kw at 0.85 pf when hydrogen pressure rises to 15 psig. Normal hydrogen pressure will be 0.5 psig.

Heat-Balance Cycle. The regenerative cycle, Fig. 5, uses four of the five turbine bleed points. In the future a fifth closed heater may be connected to the high-pressure bleed outlet to supply higher temperature feedwater to the boiler economizer. High-pressure and low-intermediate-pressure heaters have drain-cooling sections. High-pressure heater drains cascade to the high-intermediate-pressure heater. Drains from the latter are pumped to the boiler-feed-pump suction header. Drains from the two lower-pressure heaters cascade back to the main condenser.

Three 50%-capacity condensate pumps and three 50%-capacity boiler feed pumps handle water flow in the feedwater cycle.

The main condenser deaerates all the feedwater. The high-intermediate bleed point supplies the heating steam to the evaporator. Evaporator vapor and condensate discharge to the low-intermediate heater. Makeup water is introduced into the deaerating section of the condenser from the storage tank holding about 250,000 lb of condensate.

Fig. 5 gives the data for 66,000-kw gross generation producing a net output of about 62,000 kw when turbine backpressure equals 1.5 in. Hg abs. Computed station performance for these conditions with 84% steam-generator efficiency equals about 11,550 Btu per net kwhr.

Electrical Equipment. Main leads of the 13.8-kv generator run beneath the turbine pedestal, rise outdoors, and continue overhead through motor-operated disconnecting switch and 1200-amp synchronizing breaker to the main 3-phase step-up transformer. The generator and its auxiliaries will be operated from a miniature-type control board in the central control room.

The auxiliary-service transformer connects directly to the generator leads stepping the voltage down to 2400 for main services. Smaller auxiliary motors run at 480 v and lighting at 120 v.

The main step-up transformer, rated 66 mva when self-cooled, can handle 82.5 mva when force-cooled. The switchyard will be provided with the breakers and other equipment needed for connection to the transmission system. All switchyard breakers are controlled from the switchboard in the operating center. There are facilities in this center for telemetering, tieline load control, radio communication and other functions as needed. Leeds & Northrup automatic load-control equipment, suitable for working into the Middle South System plant-proportioning control, is provided. Provision has been made for carrier-current communication.

PRINCIPAL POWER PLANT EQUIPMENT

Ninemile Point Station, Unit No. 1, Jefferson Parish, La., Louisiana Power & Light Co

Steam-Generating Equipment:

Steam generator, 1.....Combustion Engineering-Superheater Inc
3-drum boiler, 625,000 lb per hr continuous, 1350 psig 955 F at superheater outlet, 17170-sq-ft waterwalls, 4940-sq-ft boiler surface, 33,300-cu-ft furnace volume, 27,100 Btu-per-hr-per-cu-ft heat release. 16,780 sq-ft superheater, 15,670-sq-ft economizer, 76,000-sq-ft tubular air heater
Burners, 12, combination oil and gas.....Forney Engineering Co
Forced-draft fans, 2.....American Blower Corp
78,000 cfm against 9.07 in. water, 1200 rpm, 250-hp motor drives
Induced-draft fans, 2.....American Blower Corp
143,500 cfm against 8.3 in. water, 720 rpm, 500-hp motor drives

Power-Generating Equipment:

Turbine-generator, 1.....General Electric Co
60,000/66,000-kw preferred standard, 3600 rpm, 1250-psig 950-F throttle steam, 2.5-in.-Hg abs exhaust pressure, 25 stages, 4 of 5 bleed points used, h-p bleed for future h-p heater. 60,000-kw generator at 0.85-pf 0.5-psig hydrogen press; 81,200 kva at 0.85-pf 15-psig hydrogen press.; 60 cycle, 3 phase, 13,800 v
Main condenser, 1.....Foster-Wheeler Corp
Two-pass twin-shell 55,000-sq-ft surface, deaerating sections
Air ejector, two-stage steam-jet.....Foster-Wheeler Corp
Circulating pumps, 2.....Foster-Wheeler Corp
Vertical, 55 cfs, 45-ft head, 600 rpm, 400-hp motor drives
Condensate pumps, 3.....Foster-Wheeler Corp
Vertical, 375,000 lb per hr, 500-ft head, 1200 rpm, 150-hp motors

Feedwater System:

Boiler feed pumps, 3.....Worthington Pump & Machinery Corp
Horizontal, 350,000 lb per hr, 3700-ft head, 3600 rpm, 1000 hp
High-press. feedwater heater, 1.....Griscom Russell Co
High-intermediate-press. heater, 1.....Graham Manufacturing Co
Low-intermediate-press. heater, 1.....Graham Manufacturing Co
Low-pressure feedwater heater, 1.....Graham Manufacturing Co
Evaporator, one 15,500-lb-per-hr.....Graham Manufacturing Co

Instruments and Controls:

Automatic combustion control.....Leeds & Northrup Co
Feedwater control.....Bailey Meter Co
Automatic boiler-feed recirculation.....Bailey Meter Co
Superheater bypass control.....Leeds & Northrup Co
Water columns.....Diamond Power Specialty Corp

Electrical Equipment:

Main power transformer, 1.....Westinghouse Electric Corp
66,000-kva self-cooled, 82,500-kva forced-draft cooled, 13.8/110-kv 3-phase 60-cycle
Auxiliary transformer, 1.....General Electric Co
6000-kva self-cooled, 7500-kva forced-draft cooled, 13.2/2.4-kv 3-phase
Oil-circuit breakers, 115 kv.....General Electric Co
800-amp 1,500,000-kva interrupting capacity
Switchgear, 2400 v.....General Electric Co
Switchgear, 480 v.....Westinghouse Electric Corp
Consolidated switchboard.....General Electric Co
Station auxiliary motors.....Allis-Chalmers Manufacturing Co
Motor controls.....Westinghouse Electric Corp

Miscellaneous:

Air compressor.....Gardner-Denver Co
500-cfm 100-psig 810-rpm, 125-hp motor drive
Piping fabrication.....National Valve & Manufacturing Co
Piping erection.....National Valve & Manufacturing Co
Reinforcing steel.....Orleans Material & Equipment Co
Soil investigation.....Eustis Engineering Co

Designers and Constructors...Ebasco Services Incorporated

ELECTRONICS FOR THE POWER ENGINEER

By F A ANNETT, *Associate Editor*

22—Oscillating-Circuit Applications

► LAST MONTH we studied resonant or oscillating circuits in their simplest form and how a feedback is used to keep them oscillating. Such simple circuit arrangements require modifying to operate satisfactorily. Here we will study some of these changes and the ways oscillating circuits are applied.

Grid-Leak Method. Fig. 1 and 2 show the grid-leak method of self-biasing an oscillating, or, as it is sometimes called, a tuned circuit. This connection is the same as Fig. 10 to 14 in the January article except that a resistor and capacitor have been added to the grid circuit. This combination is called a grid-leak.

Assume that capacitor C has been charged to the polarity shown and is transferring its energy to tank coil T as indicated. A voltage will be induced in feedback coil F, opposite to that applied to T. This voltage drives the grid positive and by grid rectification charges capacitor C_1 to the polarity shown.

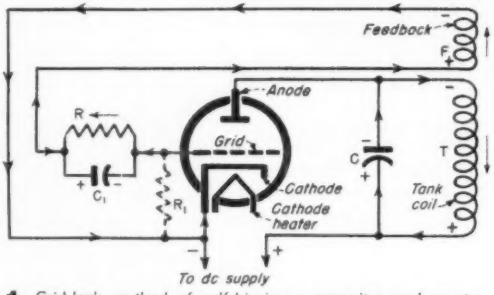
On the rising half of the feedback wave, capacitor C_1 becomes charged to its maximum value. Under this condition grid bias is practically zero because capacitor C_1 voltage opposes that of feedback coil F. Without the capacitor and resistor in the circuit the grid would have a positive bias almost equal to the peak voltage of F.

As the feedback voltage decreases from its peak value, capacitor C_1 discharges through resistor R. It also tends to discharge from the grid to the cathode through the feedback circuit opposite to its decaying voltage. This drives the grid minus where, without the grid-leak, the grid would still have a plus bias and the tube would be conducting. Resistor R has a very high resistance so capacitor C_1 discharges slowly. Consequently when the voltage of F goes to zero the capacitor drives the grid minus to block the tube.

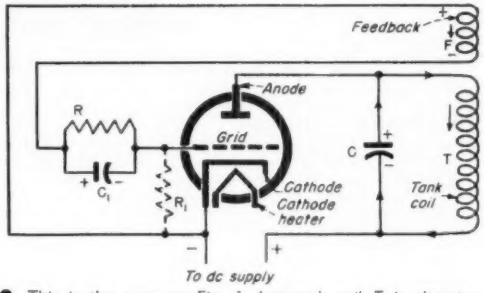
After capacitor C transfers its energy to tank coil T and current starts to decrease through this coil, voltage in F is reversed, Fig. 2. Feedback voltage is now in series with that of capacitor C_1 to drive the grid bias more minus and hold the tube blocked. This condition continues until the voltage of F passes through maximum and returns to zero.

All this time capacitor C_1 is discharging through R and its voltage is going lower. After tank coil T has given up

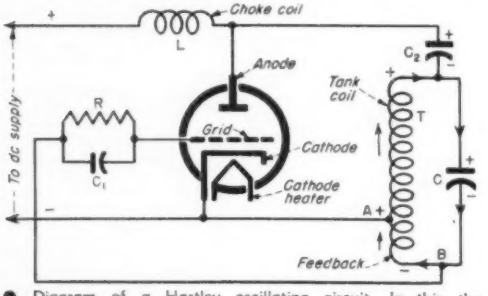
Self-Biased Oscillating Circuits With Grid Leak



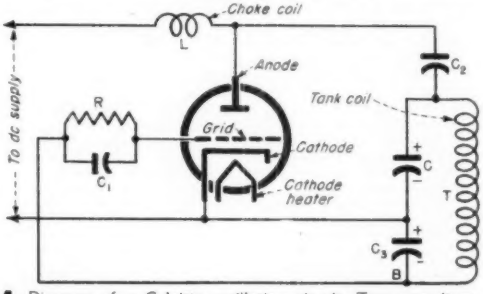
1 Grid-leak method of self-biasing a capacitor and reactor electronic oscillator; sometimes called a tuned circuit



2 This is the same as Fig. 1, but tank coil T is charging capacitor C, and the grid is given an increasing minus bias

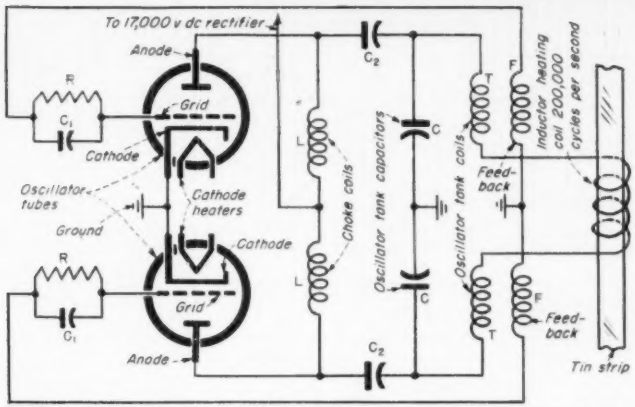


3 Diagram of a Hartley oscillating circuit. In this the tank coil is tapped to obtain excitation for the grid

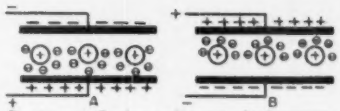


4 Diagram of a Colpitts oscillating circuit. Two capacitors, C_1 and C_2, are in series with cathode connected between

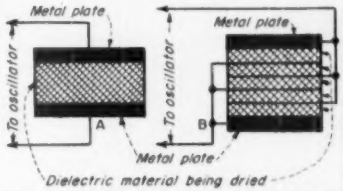
Induction and Dielectric High-Frequency Heating



5 Circuit for heating of tin plate, where the tin strip passes through the heating coil. In it, current oscillates at 200,000 cycles per second



6 *A* and *B* show electron displacement, the principle of dielectric heating



7 *A* and *B*, methods of applying dielectric heating to drying of materials

its energy to charge capacitor C to the polarity Fig. 2, the other half of the cycle takes place to return to the condition in Fig. 1.

When the tank coil started to give up its energy to charge the capacitor to the polarity, Fig. 1, voltage in F reversed to drive the grid plus again, and let the tube conduct to supply the losses in the tank circuit and keep it oscillating. Some of capacitor C_1 charge leaked off. This is replaced by grid rectification when the feedback voltage becomes higher than that of capacitor C_1, to repeat the cycle just described.

Another form of self-biasing grid-leak circuit is indicated by R_1 connected in dotted lines, Fig. 1 and 2. Instead of connecting resistor R parallel with the capacitor C_1 it is connected from the tube's grid to its cathode.

Stabilizing the Oscillator. Either grid-leak circuit tends to stabilize the oscillator. If conditions develop that tend to affect the oscillations, opposing effects are produced in the circuit—for example, if the oscillating voltage tended to decrease. Voltage fed back to the grid also decreases along with the grid current.

As a result, capacitor C_1 charge decreases, which reduces the grid bias to increase current flow through the tube and the charge in capacitor C. This tends to increase the oscillator's voltage to its original value. If the oscillator's voltage tends to increase, feedback voltage increases to up the grid bias. Anode current flow to the capacitor is thus reduced to hold the oscillating voltage to the required level.

Hartley Oscillator Circuit. Fig. 3 diagrams a Hartley oscillating circuit and Fig. 4 a Colpitts in simplified form. These circuits are the two usually found in high-frequency heating units. In Fig. 3, tank coil T is tapped to obtain grid excitation, instead of using a separate feedback coil.

Magnitude of the feedback voltage can be adjusted by changing the position of the tap on the coil. In this circuit arrangement, capacitor C_2 keeps direct current out of the oscillating circuit. High-frequency current is prevented from reaching the direct-current power supply by choke coil L.

High-frequency current circulates through all the tank coil's turns to establish the polarities shown. Current flow is up through the tank coil and down into capacitor C. It also tends to flow from B, between the capacitor and tank coil to the grid, cathode, and to the tank coil tap A. This applies a minus bias on the grid to block the tube.

When current flow reverses in the tank coil, the grid circuit is from tap A to the cathode, and grid, back to B. This gives the grid a plus bias and the tube conducts. This action is the same as for the more elementary diagrams, Fig. 1 and 2.

Now let us study how energy is fed into the oscillating circuits. When the grid blocks the tube, full dc voltage is applied from the − line through the tank coil from A, capacitor C_2 to the + line. Under these conditions we can assume that this capacitor is charged to full dc volts of the polarity shown.

Assume the grid is suddenly given a plus bias and the tube conducts. Current rush through the tube is blocked by choke coil L, which generates a counter voltage. Voltage across capacitor C_2 is now the difference between line volts and the counter volts.

Under these conditions, capacitor C_2 is charged at too high a voltage. Stored energy then flows from C_2 into the oscillating circuit until this capacitor's charge corresponds to the voltage across it. Thus by driving the grid, first minus and then plus energy is fed into the tank circuit to keep it oscillating.

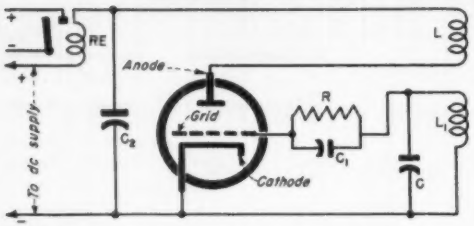
Colpitts Oscillator Circuit. In the Colpitts circuit, Fig. 4, two capacitors, C and C_3, are connected in series with the cathode connected between them. Capacitor C_3 supplies the grid bias and forms part of the tank circuit. It is selected to provide the grid bias required for proper control of the tube to keep the tank circuit oscillating.

When the capacitors have the polarity shown, they will discharge upward through tank coil T. Capacitor C_3 also tends to discharge to the grid and cathode, back to C_3, to drive the grid minus and block the tube.

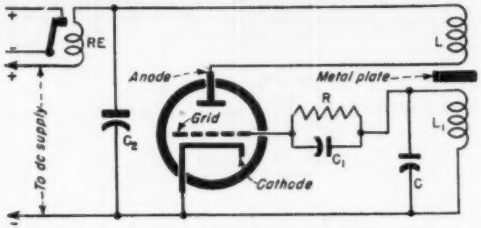
When polarity of C and C_3 reverses, they discharge downward through tank coil T. Capacitor C_3 also discharges to the cathode and grid, back to B. This drives the grid plus and the tube conducts. These operations are the same as explained for the grid circuit in Fig. 3. They cause feedback through capacitor C_2 as explained for that figure.

Both the Hartley and Colpitts circuits are widely used for electronic heating units. The Hartley circuit can be used to produce frequencies up to several million cycles per second. At very high frequencies the number of turns in the tank coil are so small it is practically impossible to locate the tap on it cor-

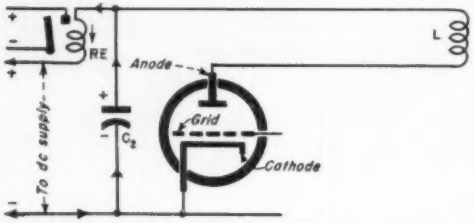
Oscillators as They Are Used in Relays and Meters



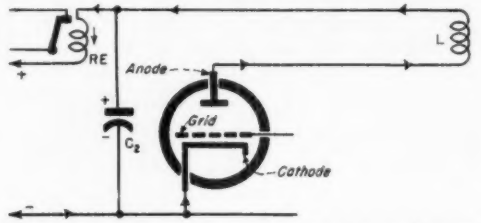
8 Oscillating circuit in which the grid circuit is tuned, which is used for the operation of relays and meters



9 Same as Fig. 8, but with a metal plate between coils *L* and L_1 to stop oscillations and to permit the relay to close



10 Relay circuit, Fig. 8, under conditions of minus bias on the grid, blocks tube and stops current flow in coil *L*



11 Grid minus bias has been removed. The tube conducts and current through coil *RE* reaches value that closes relay

rectly. The Colpitts circuit usually has less frequency drift with load change.

All the oscillating circuits described so far are in simplified form. They lack the transformers and rectifiers required to supply high-voltage dc to many heating circuits, also the means of applying the high-frequency current to the work to heat it.

Induction-Heating Oscillator. Fig. 5 shows a more complete circuit for induction heating of tin plate. In this, the tin strip passes through an inductor heater coil in which current oscillates at 200,000 cycles per second. The high-frequency magnetic field produces large eddy currents in the metal strip in which the tin has been deposited by an electroplating process. Temperature of the strip is raised quickly to where the tin melts and flows evenly on the strip as it passes continuously through the coil at speeds up to 1000 ft per min.

The oscillator tank coil is divided in two parts and the inductor heating coil connected between them. All three coils are part of the tank coil circuit. There are two oscillator tank capacitors, *C* and C_1, which indicate that the oscillating circuit, Fig. 5, is a Colpitts. A separate feedback coil *F* couples with each half of the tank coil to provide grid bias to the two tubes.

Capacitors C_2 keep direct current out of the oscillating circuit. Choke coils *L* prevent high-frequency current reaching the dc power supply. Instead of one oscillating tube, Fig. 4, we have two in Fig. 5. This permits feedback into the oscillating circuit every half cycle instead of each cycle, Fig. 4.

Dc power is supplied to the oscillator at 17,000 v from a 3-phase or 6-phase rectifier. Minus terminal of this rectifier is grounded as is the connection between the oscillating tubes, the tank capacitors *C*, and the two grid feedback coils *F*. Plus terminal of the rectifier connects between choke coils *L*.

As we have identified the different parts of the circuit, Fig. 5, we see it is practically the same as Fig. 4 in duplicate and can be treated as such.

Induction heating is applied in many ways but each depends on generating eddy currents in the material heated. So induction heating can be used only for materials that are electrical conductors.

On the other hand, dielectric heating is applicable only to materials that are normally poor conductors or insulators. In this process, heat may be considered as being produced by displacing the electrons in the material, first in one direction and then in the other. This movement of electrons causes heating in the insulation between the plates in a capacitor on ac just as electron movement in a conductor causes heating.

Dielectric Heating. Fig. 6*A* and 6*B* illustrates the principles of dielectric heating. Here we have insulating material (a dielectric) between two plates. When the top plate is minus and the bottom plus, the electrons are forced toward the bottom of each atom, Fig. 6*A*. Reversing the capacitor's polarity, Fig. 6*B*, tends to force the electrons above the atoms.

If the capacitor is connected to a one-million-cycle circuit, the electrons will be rattled up and down one million times per second. Under such treatment it is not difficult to realize that the material will heat.

Dielectric heating has many applications in industry. Among them are the curing of plastics, preheating of materials before they are put in molds, the gluing of plywood, and drying of lumber. One advantage is that the material heats uniformly through its cross section.

How the heating is done depends on the thickness of the material. If it is quite thick it is placed between two plates, Fig. 7*A*, and connected to the oscillator. In this case we have a 2-plate condenser, one plate connected to each terminal of the oscillator.

If the material is thin, like plywood, several layers may be stacked one on another with a thin metal plate separating each layer. Alternate plates are connected in parallel to form two groups, Fig. 7*B*. The two leads are connected to the oscillator.

Frequencies used in induction and dielectric heating vary with the class of work. In induction heating, frequencies as low as 1000 cycles per sec may be used for through heating of

(*Continued on page* 158)

NEW Edward INSTRUMENT VALVES

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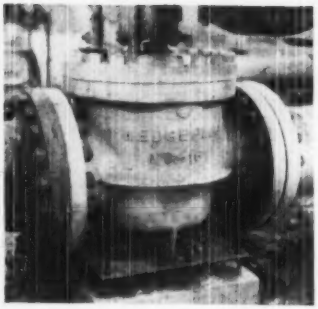
POWER ENGINEERS' NOTEBOOK

PLANT-TESTED IDEAS TO SOLVE PROBLEMS OF DESIGN, OPERATION AND MAINTENANCE

QUICK WAY TO SET AND LEVEL A HEAVY VALVE



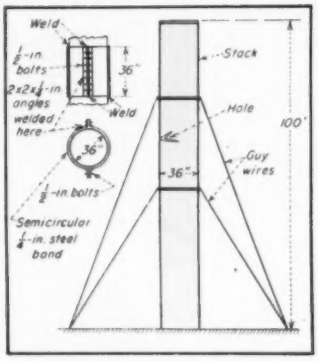
WHEN GROUTING a valve baseplate to desired level, one engineer sets 12 bolts into the valve foundation, instead of supporting abutting pipe ends on temporary cribbing. He then drills matching holes in the ½-in.-thick baseplate, see photo. Nuts, run on to the bolts, support the plate and valve. An additional nut on each bolt above the plate holds it rigidly in place. With this arrangement the level can be adjusted with micrometric accuracy.

After aligning the valve properly with the pipe flanges on each side, the grout is placed under the baseplate by the usual methods. Finally the protruding ends of the bolts are cut off even with the upper faces of the nuts above the plate.

Since the four wings or arms forming the spider under the valve body are concave toward the center, weight of the valve is supported near outer edges of the plate. There is no need for adjustment or support toward the center. No fastening of the valve to its support need be provided. Clamping the pipeline to its supports takes care of possible line shifts.

ELTON STERRETT *Houston, Texas*

PROMPT REPAIR ADDS LIFE TO METAL SMOKESTACK



DURING A PERIODIC INSPECTION of our smokestack, through binoculars, we discovered a hole. Roughly 18 in. long, it was about 1¼ in. wide in the center and tapered off as shown in the sketch. It was about 4 ft below the upper guy wires. The metal stack stands 100 ft high and has a diameter of 36 in.

Examining the stack from a bosun's chair showed the metal all around the hole to be in sound condition. Since the hole removed less than 20% of the stack circumference at its level we decided to save the stack by patching. The ¼-in. metal of the stack was in good condition throughout its length.

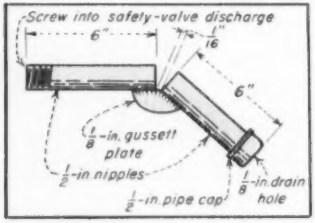
We made up two semicircular steel bands, 36 in. long from ¼-in. plate, to encompass the stack and cover the hole with plenty of overlap. We then welded 2x2x¼-in. angles to the straight sides of the bands. Holes were drilled in the angles through which bolts could be inserted. Nuts and bolts were used to pull the bands together.

The two halves of the "patch" were tacked in place by acetylene welding. The ½-in. bolts were then pulled up tight. From ⅛ to 3/16 in. was left between angle faces after tightening.

As the final step we placed a welding bead around the bottom and top of the patch and between the angles. This prevents rain water entering behind the patch and causing further corrosion.

FRANK COWAN *Perry, Iowa*

SIMPLE PIPE WHISTLE CONSERVES STORED GASES



ELIMINATION OF LOSSES from stored gases and volatile liquids under pressure becomes very important when tanks are unattended. On such units, to call attention to safety valves popping, they can be fitted with a whistle made of ½-in. pipe nipples as shown in the sketch. Two ½-in. nipples, 6 in. long, welded to a ⅛-in. gusset plate, make up the sounding elements. Thread the outer ends of each nipple. One end screws into the safety-valve discharge outlet, the other end receives a pipe cap. To prevent water accumulating in the inclined pipe, drill a ⅛-in. hole in the cap.

When the gasified liquid or gas escapes from the safety valve, the whistle is loud enough to attract the operator's attention.

J CONSTANCE *Cliffside Park, N. J.*

(*Continued on page* 128)

SEATLESS MEANS ECONOMY

IN BOILER BLOW-DOWN SERVICE

Because they eliminate the commonest source of trouble and expense in ordinary blow-off valve service, Yarway *Seatless* Blow-Off Valves mean real economy to boiler plant operators. *Yarways have no seat to score, wear, clog and leak.* Lubrication is usually the only maintenance they require.

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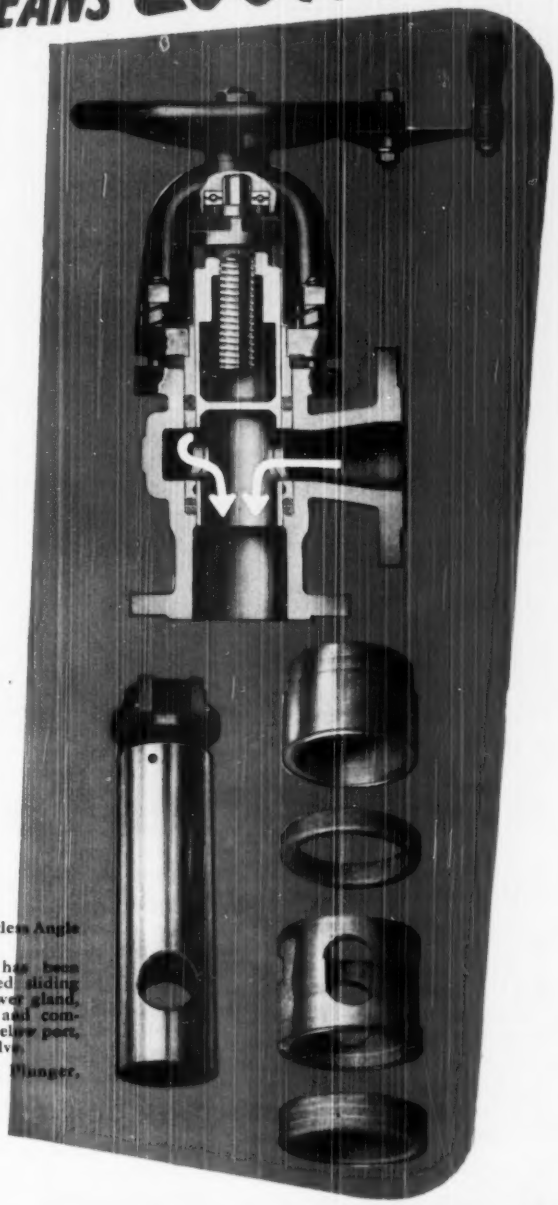


(*Above*)—Cross section of Seatless Angle Valve, flanged.

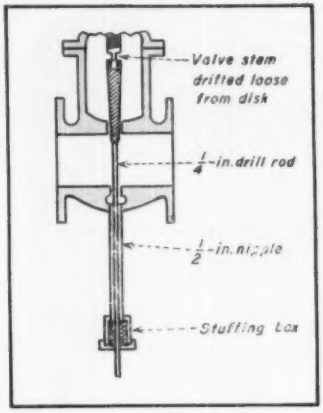
OPERATION: After valve has been closed, shoulder on balanced sliding plunger contacts upper follower gland, forcing it down into body and compressing packing above and below port, making an absolutely tight valve.

(*Below*)—Balanced Sliding Plunger, Packing Rings and Glands.

YARWAY **BLOW-OFF VALVES**

 (*Continued from page 126*)

HOW WE OPENED A GATE VALVE WITH A BROKEN STEM



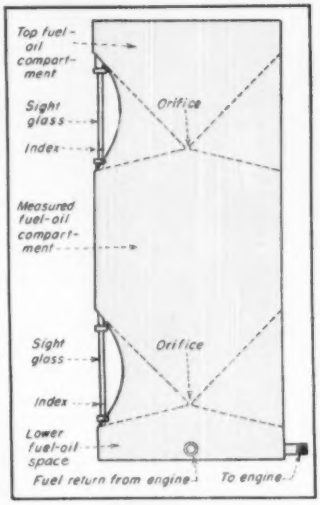
WE HAVE THREE PUMPS supplying cooling water at 150 psig. Normally two pumps run while the third stands idle as standby. One of the pumps in operation developed mechanical trouble one day and had to be shut down. On starting the standby pump we were unable to open its discharge valve. The stem became disengaged from the valve disk.

Since we could not dismantle the valve without shutting down the plant we had to devise a way of opening it. First, we turned the stem down tight to make certain the valve remained closed. Second, we drilled a small hole (⅛ in.) through the body directly under the disk to check that the valve was closed. Third, when no water leaked through this opening we drilled and tapped it to take a ½-in. nipple. To this we attached a stuffing box as shown in the sketch. Through this passage we inserted a ¼-in. drill rod. Actually we had a small gate valve in the line between the stuffing box and the large valve, but found we didn't need it because the main valve had to stay open.

Fourth, pressure on the valve disk was released by unscrewing the stem clear of the disk. The pump was started to equalize pressure on both sides of the disk. It was released by a hammer tap on the drill rod and then pushed up. To keep the valve open, the end of the rod was tied to its body. This method was satisfactory and we repaired the valve during the next scheduled plant shutdown.

S B MORO *Montreal, Canada*

CONSTANT-VOLUME TANK CHECKS DIESEL-ENGINE PERFORMANCE



ONE OF THE BEST WAYS to maintain plant performance is to know your engine's specific fuel consumption exactly. This can be done, when they drive generators, by running them at constant load. And while they burn a measured amount of fuel, count the revolutions on the watthour meter recording their output. Dividing the rate of fuel burned by the measured output rate gives the specific fuel consumption.

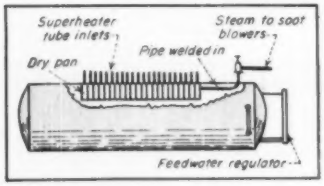
To get an exact measure of the fuel, we built the tank shown in the sketch. It holds exactly 100 gal between the top and bottom orifice. It can be built to hold any convenient amount, depending on engine size, and the exact quantity determined by calibration. Feature of the tank is the exactness with which it shows the beginning and end of consumption of the test amount. The tank has three compartments separated by conical sections connecting through the orifices.

In use, the tank is completely filled. Then as constant rate of fuel drainage from the tank continues, with the engine run at constant load, the fuel level drops uniformly. But as the level enters the conical section, the level in the upper sight glass begins falling at an accelerating rate. It will be dropping fastest when passing the index mark indicating the start of consuming the measured amount of oil. At this point the stop watch is started. When the measured amount drops to the lowest orifice, the level will again be dropping fastest as it passes the index mark in the lower sight glass. At this point the stop watch is stopped. Dividing the known amount of oil by the time gives the rate of fuel consumption.

The tank is open on top for filling. The lower tank has two connections, one for fuel feed to the engine, the other for overflow return from the fuel rail. We made our tank body of 8-gage metal and the partitions of 16 gage.

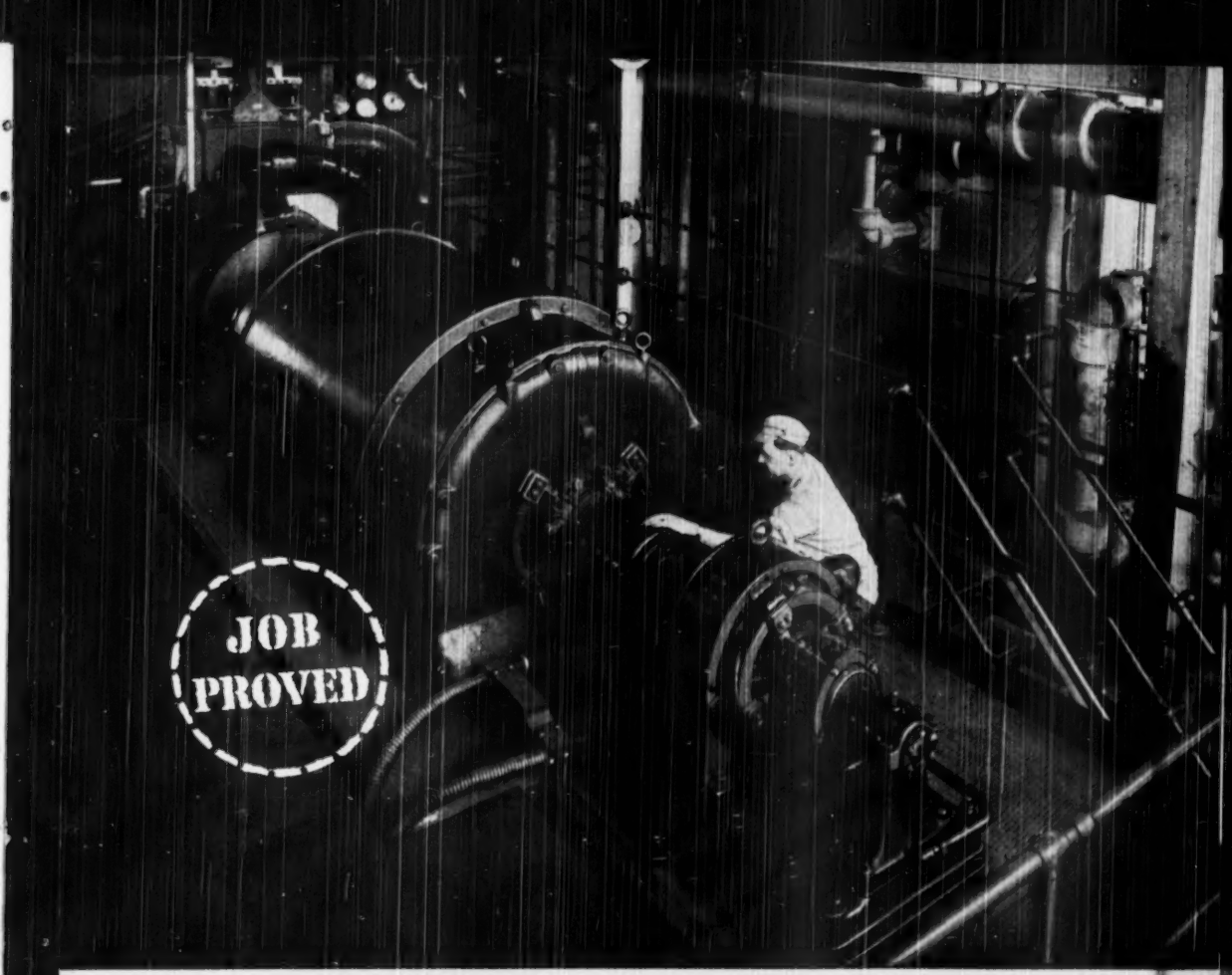
HENRY GREINER *Anoka, Minn.*

REPIPING SOOT-BLOWER CONNECTION CURES TROUBLES



WE HAVE TO OPERATE 24 sootblowers in our black-liquor-burning boiler every three hours. When the blowers took their steam from the end of the drum, near level gage and feed regulator, feedwater level would rise and then drop out of sight with each operation. This made the regulator vary with the same cycle and raise the superheater temperature about 100 F. To minimize these fluctuations we piped up the sootblower steam outlet to the dry pan of the superheater inlet within the boiler drum as shown in cutaway sketch, at left. This has eliminated the wide level fluctuations, and steam temperature rises only about 50 F.

E B CLEMENTS *Tuscaloosa, Ala.*



PROTECTED BY SUNVIS 916

Turbine Bearings and Journals Corrosion-Free Despite Summer Shutdowns — Oils Like New After 9,000 Hours

Three years ago, a paper mill overhauled a steam turbine. Thereafter, it was planned to operate this equipment on a 'round-the-clock schedule during the six winter months, and completely shut down in the summer. On the advice of a Sun Engineer, the mill charged the circulating system supplying turbine, generator journals, and governor with Sunvis 916. This oil was chosen because of its "Job Proved" ability to prevent rust and corrosion and to give troublefree lubrication for a long period of time.

The management's selection of Sunvis 916 proved to be sound. After 9,000 hours, a laboratory analysis of the oil showed it to be unchanged—comparable to a sample of new oil. Even more important, inspection showed no abnormal wear and no corrosion in bearings and journals, despite the summer-long shutdown.

The turbine has now operated 12,000 hours without oil-change, and it appears that none will be necessary in the foreseeable future.

All oils in the Sunvis 900 series have a high viscosity index, are fortified against oxidation and sludging, and prevent rust and corrosion. Sunvis 900 Oils are the finest lubricants available for turbines, hydraulic systems, and similar applications. For a free, illustrated booklet on Sunvis 900 Oils, write Department P-2.

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PROBLEMS FROM THE PLANT

READERS ANSWER THE NOVEMBER QUESTION...

What Steam Pressure for Vat Heating?

OUR QUESTION *involves cooking malt and corn. We have to handle the piping job in connection with a steam-heated vertical sheet-steel vat. Vat is 8 ft high with inside diameter of 13 ft. It will be steam jacketed at the bottom and 2½ ft up the sides. Separate mechanism is provided to stir the mixture while cooking. Total inside heating surface is 233 sq ft.*

Mixture will consist of 1000 lb malt, 3100 lb grits (corn) and 20,900 lb water. First heat will bring temperature of the cook from the original 113 F to 158 F in 15 min. After this there is a rest or holding period of 30 min when temperature is kept at 158 F. Then the second heat brings mixture to 212 F in 20 min.

Assuming proper condensate drainage and air elimination, our problem is to determine steam pressure to be carried in the jacket. On top of that we have to know steam flow and pipe size to the jacket. We will use two traps and our next problem is to determine size of each.—CP

THE ANSWERS

Calculations Step-by-Step

ALTHOUGH SPECIFIC HEATS of the substances being cooked vary, we may treat the entire mass as water with a specific heat of unity. The ample safety factors justify this liberty.

Mathematical steps required are outlined at right. In determining rate of heat transfer, step 2, note that 15 min is used in the first case and 20 min in the second.

In calculating mean temperature difference, I felt a coefficient of heat transfer, *K*, of 300 would be a conservative figure since the vat is steel. This allows for corrosion, condensate film, etc. It means each sq ft of heating surface would transmit 300 Btu per hr to the liquid, from the steam, for each degree of mean temperature difference. Since heat must be transferred at the rate of 4,500,000 Btu per hr, dividing this figure by *K* times 233 sq ft, gives a theoretical mean temperature difference, TMTD, of 64.2 F for the first heat. For the second heat, TMTD is 58 F. And this means steam temperature for heating must be 65 F and 58 F (for heats 1 and 2), higher than average liquid temperature.

After introducing a safety factor of 2 and determining the true or logarithmic mean temperature difference, the next step, 6, is more or less trial and error. But after computing a few of these problems it is possible to estimate the required steam pressure rather closely. After comparing the TMTDs of 116 F with the 120 F for 60-psig steam, the second heat becomes the determining factor and we may consider 60 psig a safe pressure to use.

Now the glove is on the other hand as far as trap size is concerned. Here the first heat becomes the determining factor since the greatest number of Btu's are required at this point. Dividing the required Btu's by 904 (latent heat of steam at 60 psig) we find 5000 lb of steam per hr will be condensed. Using a safety factor of 2 for trap selection, *CP* should use two 1½-in. traps, each with 5000-lb-per-hr capacity at 60 psig.

In calculating size of steam line, I suggest using a maximum steam velocity of 9000 fpm, or 150 fps. Multiply the total steam, 5000 lb per hr, by 0.04 (a conversion factor). Then multiply the result by specific volume of steam at 60 psig, 5.8. Divide this total quantity by 150 fps. From there on it's simply a matter of matching the calculated internal pipe area to the conventional pipe sizes.

H G EBERT *Philadelphia, Pa.*

VAT-HEATING CALCULATIONS

1. Material: 20,900 lb water + 3,100 lb grits + 1,000 lb malt = 25,000 lbs

2. Btu required (first heat) $= \frac{25{,}000 \times (158-113)}{1/4 \text{ hr}}$
$= 4{,}500{,}000$ Btu/hr

Btu required (second heat) $= \frac{25{,}000 \times (212-158)}{1/3 \text{ hr}}$
$= 4{,}050{,}000$ Btu/hr

3. Theoretical mean temperature diff

(First heat) $= \frac{4{,}500{,}000}{300 \times 233} = 64.2$ say 65F

(Second heat) $= \frac{4{,}050{,}000}{300 \times 233} = 58$F

4. Use Safety Factor of 2

$TMD_1 = 65 \times 2 = 130$F

$TMD_2 = 58 \times 2 = 116$F

5. Log mean temp diff $= \frac{TD(max)-TD(min)}{2.3 \log \left[\frac{TD\,max}{TD\,min}\right]}$

6. Assume steam at 60 psi is 307 F

First heat	Second heat
307 − 158 = 149	307 − 212 = 95
307 − 113 = 194	307 − 158 = 149
Diff = 45	Diff = 54

$LMTD_1 = \frac{45}{2.3 \log \frac{194}{149}} = 170$F

$LMTD_2 = \frac{54}{2.3 \log \frac{149}{95}} = 120$F

hence 60-psig steam OK

7. Trap size $= \frac{4{,}500{,}000 \text{ Btu}}{904} = 5000$ lb/hr

Use Safety Factor of 2

$\frac{5000 \times 2}{2} = 5000$ lb/hr cap

Use 2, 1½ in. traps

8. Steam line to tank

$\frac{5000 \times 0.04 \times 5.8}{150} = 7.73$ sq in., say, 3 or 3½ in.

All Hinges on K Factor

EDITOR'S NOTE: Following answer agrees in general with the mathematical outline of Ebert's reply above, up to step 3. Going on from there. . .

SELECTION OF *K* factor is the heart of the problem. Given mixture suggests an end product having consistency of oatmeal. But on the other hand, if tank has a stirrer it would tend to increase value of *K*.

Assuming "on" and "off" steam, pressure is governed by the second

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heat since it has a lower temperature difference between steam and product. So 4,050,000 Btu ÷ 233 sq ft = 17,400 Btu per sq ft per hr. Then assuming a K of 200, temperature difference is 17,400 ÷ 200, or 87 F.

Logarithmic mean temperature difference between 158 F and 212 F is 186 F. Therefore 186 F plus 87 F (temperature difference) equals 273 F, which corresponds to a pressure of 30 psi. Condensate figures to 4,050,000 ÷ 928.2 = 4360 lb per hr.

Using 593 sq ft as total tank area and 200-F temperature difference, we get a radiation loss of 2.39 Btu per hr, per sq ft, per deg F. Hence, (593 × 200 × 2.39) ÷ 928.2 equals 304 lb of condensate.

Assuming weight of cooker is 7500 lb, temperature rise for second heat is 54 F, and water equivalent of steel is 0.114, then:

$$\frac{7500 \times 54 \times 0.114 \times 3}{928.2} = 149.1 \text{ lb per hr}$$

Adding the steam rate for second cycle, radiation loss and steam to raise temperature of cooker we find total steam rate required is 4813 lb per hr.

This figure is a bare minimum. There is additional heat loss because of vapor leaving top of tank. Furthermore, rate of flow will vary. On starting up, steam demand will be close to 10,000 lb per hr.

If there is an unlimited supply of 30-psi steam available close to the vat, I recommend an 8-in. supply line. On the other hand, if the supply pressure is 35 psi, a 6-in. line is sufficient. But if the only steam supply available is, say, 125 lb—located some distance from the cooker—it might be more economical to pipe the high-pressure steam to the cooker and put in a reducing-valve station.

Since peak load on unit will be close to 10,000 lb per hr when starting up, each trap must handle 5000 lb per hr continuous discharge. A safety factor of at least 3 to 1 is indicated meaning that two traps, each with a continuous discharge capacity of 15,000 lb per hr, will be required. These traps would have a 2-in. connection, ¾-in. orifices and extra air-venting capacity.

T H Rea *Three Rivers, Mich.*

Test Similar Apparatus

Heat flow through heat-transfer apparatus ranges from 2 Btu to about 4000 Btu per deg-hour-sq-ft. This depends on construction, agitation, viscosity etc. Highest steam pressure is required when heating from 158 to 212 F. If heat flow is 100 Btu deg-hour-sq-ft, logarithmic mean temperature difference between steam and liquid is about 180 F, steam temperature about 365 F, and steam pressure about 150 psi. But heat-flow rate cannot be predicted solely from theory. *CP* should experiment with similar apparatus using similar agitation, ingredients, etc.

Find trap size from manufacturer's capacity tables. Steam flow during heating-up periods will be a little under 5000 lb per hr. *CP* can discharge condensate by a hand valve until jacket pressure is determined or can get traps big enough to handle double the volume of condensate at a low pressure, say, 5 psi. For a popular make of inverted bucket trap, two 1½-in. traps with 7/16-in. orifices would be large enough.

Arthur Holt *Atlantic City, N.J.*

EDITOR'S NOTE: Majority of the following answers follow a pattern similar to those above. So, because of limited space, each reply was condensed, leaving only new facts or approaches.

First Try Pilot Cooker

CP can attack the problem in two ways: one involves assumptions for heat transfer rates and specific heat of malt, corn and water mixture. Other plan is setting up a pilot plant and measuring steam consumption by trapping and weighing condensate.

Pilot cooker can be a steel drum of about 40-gal capacity with head removed. Insulate the outside and load with 1/100 of a normal charge. Measure liquid depth and insert pipe coil having an external area of 2.33 sq ft. Trap the coil and discharge condensate into a barrel or tank partly filled with cold water. Weigh this tank at the beginning and end of each cooking operation to find amount of condensate for any period. Steam gage and throttle valve on the coil, plus a thermometer and watch, are all the instruments needed.

Use a portable agitator, taking care that velocity of liquid over coils is essentially the same in both pilot and production unit. Rough check on steam requirements can be made by assuming specific heat of corn and malt as 25% that of water. This gives us 66 lb per min for first stage and 59.4 for second. Piping should be capable of handling first-stage flow plus an allowance for condensation loss from outside of jacket and kettle. Assuming the maximum steam flow as 4500 lb per hr, mean temperature difference between steam and charge would be (4500 × 1000) ÷ (233 × 200) = 9.67 F, assuming heat-transfer rate of 200 Btu per sq ft per hr. Steam pressure of 5 psig would be adequate. In fact, this pressure will have to be reduced for most of the cooking period. As for pipe size, a 5-in. line will do the trick.

Traps should have at least 25% greater capacity than indicated maxi-

(*Continued on page 176*)

THIS MONTH'S QUESTION

How Can We Separate Water From Lube Oil?

Here's one we have been batting around, about lube oil and ammonia compressors. We have two mechanical lubricators—one for each of two 8x8 ammonia compressors—for oiling cylinder walls. After a long search, we tagged these two lube systems as the culprits responsible for getting water into the lube oil.

We always take care to fill lubricators with pure oil. But on draining we often notice large quantities of water globules suspended in the oil. The same condition reappears a day or two after refilling.

It is difficult to account for the water. My guess is that it condenses somewhere within the working parts of the equipment during cold weather. Then again it may be that, because of traces of ammonia gas in the oil, it absorbs minute particles of water from the air. There seems to be no other explanation since we carefully check all oil in front of a bright light before filling.

Is there a simple, inexpensive way to filter out this finely divided moisture that would fit well into our present lubricating setup? Yes, we have tried passing the oil through cotton cloth and through rayon but with only partial success; portion of water persists in coming through with the oil.—*WK*

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REVIEWED IN THIS ISSUE

FUELS AND FIRING: Studies of Industrial-Gas Combustion With Oxygenated Air • Effect of Pressure on the Combustion of Pulverized Coal • Some New Developments in the Use of Flyash

NUCLEAR POWER: Atomic Power and Fuel

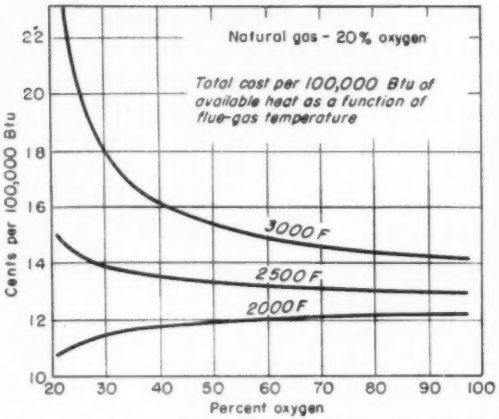
HYDRAULICS: Calibration of Six Beth-Flow Meters • Resistance to Rotation of Disks in Liquids

ELECTRICITY: Determining Incremental Regulation and Dead Band of Governors on Steam-Turbine Generators

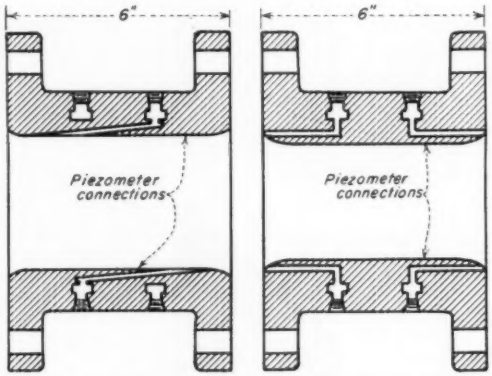
COAL HANDLING: Philadelphia Electric Co Adopts Mobile Coal Handling • Storing, Reclaiming Coal With Earth Moving Equipment

BEARINGS AND DRIVES: Ball and Roller Bearing Identification Standard and Design • Power Capacity of a Roller Chain Drive

Directions for ordering papers are given on page 136



1 Theoretical flame temperatures and available heat with an oxygenated air will greatly influence combustion design



2 Varying throat diameter and piezometer arrangements of Beth-flow meters produced interesting flow coefficients

FUELS AND FIRING

STUDIES OF INDUSTRIAL-GAS COMBUSTION WITH OXYGENATED AIR, *by E N de Coriolis, director of research, and Jack Hueber, research engineer, American Gas Association.* Recent technological progress has resulted in the development of commercial oxygen plants that produce oxygen at such low cost its use in industrial combination processes may be feasible. Depending on installation size and other pertinent factors, low-cost oxygen ranges from 20 to 50 cents per 1000 cu ft. Purity of oxygen varies from 95 to 97% oxygen. The rest is nitrogen.

Since most engineers have had little or no direct experience in burning gas with oxygenated air, this paper gives a general outline of the subject. Generally speaking, we may predict that with oxygen enrichment flame temperatures will be higher, ignition limits wider, combustion velocities greater. Just what comparative costs are and where it is cheaper to burn oxygen than air are subjects that are not discussed.

The paper begins with a survey of known information. Principal contributors are Justi and Zeisi, German scientists. The authors follow up this discussion with calculations of theoretical flame temperature and available heat. A series of tables shows results of calculations for fuel gases like carbon monoxide, hydrogen, methane, natural gas, Fig. 1, and manufactured gas.

Examples of the use of calculated data are given. Some of the possible reasons why oxygen or oxygen-enriched air would be desirable are: greatly reduced volumes of flue gas for available Btu, increased burning velocities, higher flame temperatures, wider ignition limits. *AGA paper. No number.*

EFFECT OF PRESSURE ON THE COMBUSTION OF PULVERIZED COAL, *by T T Omori, California Institute of Technology, and A A Orning, Coal Research Lab, Carnegie Institute of Technology.* This paper is a theoretical study of heat transfer to a sphere suspended in cold air and suddenly exposed to radiation from a higher-temperature surface. When this particle was observed under an air pressure there seemed to be an effect on ignition not previously noted.

Experimental investigation was carried on in the absence of an extended flame so the source of radiant heat could be controlled. Elevated pressures showed an adverse effect upon completeness of combustion, which was much larger than any beneficial effect from increased partial pressures of oxygen. Under atmospheric furnace pressure the temperature responsible for ignition affected the ability of residual combustible particles to keep on burning once they left the flame. Apparently the initial heating rate was too low.

To keep these residual particles burning depended on the ability of the particles to hold temperatures above

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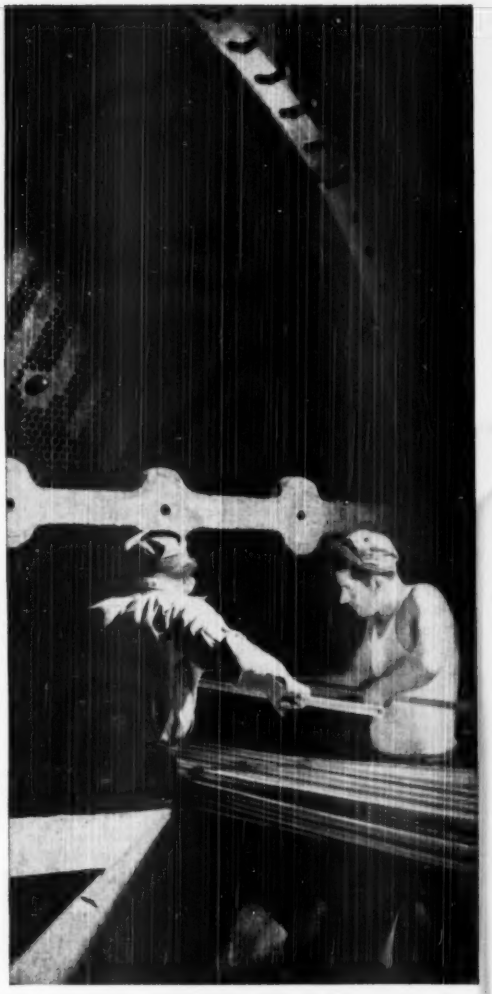

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1000, and possibly nearer 2000 C. Such temperatures ran much higher than the surroundings of the particles.

As far as gas-turbine work is concerned the problem of complete combustion of pulverized coal is not the need for greater combustion space, but rather inadequate ignition intensity. *ASME paper No. 49-A-72.*

SOME NEW DEVELOPMENTS IN THE USE OF FLYASH, *a panel by Henry S Walker, director of research, Detroit Edison Co; M C Randall, Philadelphia Electric Co; C M Weinheimer, Detroit Edison Co; Walter N Handy, Combustion By-Products Co.* New developments in the use of flyash promise to solve a disposal problem saddling privately owned utilities with collecting equipment rapidly approaching $60,000,000 in value.

New uses for the ash—a residue from burning pulverized coal—are in soil stabilization, insulating cement, building brick.

M C Randall explained that a mixture of limestone screenings, flyash, and a small amount of hydrated lime have been developed at his company for supporting a concrete pavement and a cementatious fill. They will replace the customary limestone screenings normally used as the base course for bituminous concrete pavement.

When flyash is used in making cement, a remarkable lack of shrinkage is noted when the cement has dried. There is excellent adhesion to base insulating materials. Workability seems good and coverage is equal if not somewhat better than present commercially available cements.

Walter N Handy described the advantages of flyash in concrete as a part of the cementing material.

C M Weinheimer outlined the development of flyash in the bitumastic road industry. Detroit sold 31,200 tons in 1946 alone for use as a mineral filler in road construction. *ASME paper No. 49-A-79, 81, 82, 83.*

NUCLEAR POWER

ATOMIC POWER AND FUEL SUPPLY, *by Ward F Davidson, research engineer, Consolidated Edison Co of New York, Inc.* No common engineering material is suitable for structural use in an atomic nuclear reactor. All interfere with pile operation by absorbing too many neutrons. So the quantity of structural material must be severely limited, also the materials must not deteriorate rapidly under the radiation in the reactor.

Again, the structure must be extremely compact to conserve neutrons. This requires high rates of heat transfer and high mechanical unit stresses—both incompatible with reliability. Yet reliability is extremely important because it is almost impossible to repair a reactor after it has been put into operation and has become radioactive.

Gilliland, author of a book on nuclear power, has selected four media as promising for heat transfer in reactors: helium, water, molten cadmium and molten lead. Other investigators add air and metallic mixtures involving lead. Molten metal, if used, would circulate through the reactor to pick up heat, and then through a steam generator or heat exchanger to generate steam or heat gas for gas turbines. This arrangement isolates the turbine and its auxiliaries from the radioactivity that the fluid picks up in the reactor.

One difficult problem of reactor design is a means for removing the partially spent charge and replacing it with new, active fissionable materials. A continuous process would have many advantages. The control of a pile is extremely sensitive, and many instruments and several mechanisms are required.

The steam generator itself presents some new problems. For compactness heat-transfer rates must be very high and heating surfaces extremely clean. Instead of the very large boilers now used for steam generation there would be a much smaller reactor encased in a massive concrete-and-steel shield, plus the steam generator in a less massive shield. Large circulating pumps would handle the molten-metal heat-transfer fluid.

A complete nuclear power station might cost $370 per kw as against $190 for an ordinary power plant. Under present conditions uranium fuel is more costly than coal, but it may become less expensive. For quite a time labor, supervision, maintenance and repair will be higher for the nuclear plant.

For many years no prudent engineer will place a large nuclear power station in the heart of a densely populated or industrially important area. The need for location elsewhere may be a disadvantage. Also, the problem of removing radioactive wastes to distant points may be difficult.

On the other hand, the nuclear fuel is so concentrated that its haulage is no problem. Under the circumstances, you would not expect rapid large-scale inroads of nuclear power into the picture of industrial power production. At most it would become a supplement, rather than a substitute, for power from coal, oil, gas and water. *ASME paper. No number.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from one of the following sources:

American Institute of Electrical Engineers, fall general meeting, Cincinnati, Ohio, Oct 17-21, 1949. Papers are identified by number and initials AIEE. Available from AIEE, 29 W 39th St, New York 18, N. Y.

American Gas Association, annual convention, Chicago, Ill. Oct 17-20, 1949. Papers are identified by number and initials AGA. Available from AGA, 420 Lexington Ave, New York, N. Y.

American Society of Mechanical Engineers, fuels div meeting, French Lick Springs, Ind. Oct 26, 27, 1949; annual meeting, New York, Nov 28-Dec 1, 1949. Papers are identified by number and initials ASME. Available from ASME, 29 W 39th St, New York 18, N. Y.

HYDRAULICS

CALIBRATIONS OF SIX BETH-FLOW METERS AT ALDEN HYDRAULIC LABORATORY, *by L J Hooper, Worcester Polytechnic Institute.* The Beth-Flow meter. Fig. 2, is as yet in the laboratory stage of development. But it showed certain desirable features for flowmeter service in the design stage so laboratory models were put under test.

The various tests were conducted with a 3-ft-diameter tank as the distribution center for water supply. Such a center reduces velocity effects at the entrance to the test section. A test section of either 4- or 6-in. pipe was connected to a 12-in. feed pipe in the tank proper. The approach pipe to the meter was 25 ft long. All necessary dimensions, weights and velocities of fluids involved were carefully determined.

Differential pressures developed by the flowmeters were observed by differential manometers. Four of six different meters showed the same coefficients of flow in either direction. These coefficients reached a constant value with a Reynolds number of about 100,000 based on throat velocity. This corresponds to a throat velocity of nearly 6 ft per sec.

Only difference between the six tested meters is the upstream throat-diameter ratio and the piezometer arrangements. *ASME paper No. 49-A-38.*

RESISTANCE TO ROTATION OF DISKS IN LIQUIDS, *by Austin H Church and Stanley A Gertz, New York University.* The purpose of this paper is to examine the retardation of a disk rotating in a liquid. This problem is of consequence to the design of all types of centrifugal machinery in which an impeller rotates in a fluid. For centrifugal pumps the

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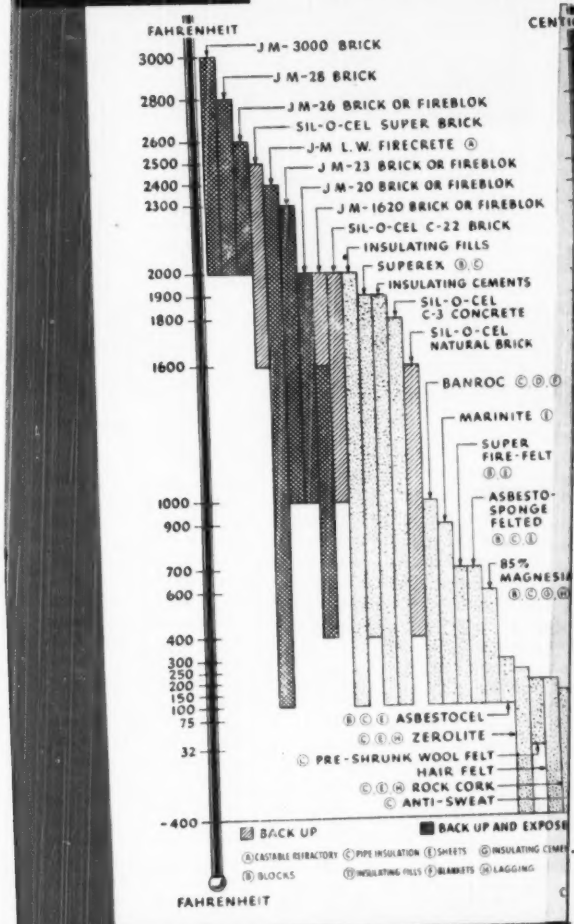

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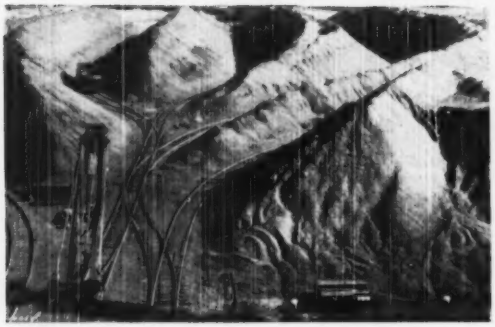


3 Former coal-storage system of Philadelphia Electric, *above*, had coal in parallel piles with railroad tracks between

4 Mobile coal-handling let company remove tracks. Pile, with 180,000 tons storage, above, as against 150,000, *left*

power absorbed by the liquid ranges from 2 to 15%, or more, of that delivered by the driver. The percentage becomes larger when oil or other viscous liquids are being handled.

Work of previous experimenters is reviewed and the factors involved are discussed. Tests on oil and water are described, the results analyzed and correlated with those of earlier investigators. A formula based on the Reynolds number of the disk and liquid is obtained. It includes the properties of liquids and the side clearance. *ASME Paper No. 49-A-103.*

ELECTRICITY

DETERMINING INCREMENTAL REGULATION AND DEAD BAND OF GOVERNORS ON STEAM TURBINE-GENERATORS UNDER SYSTEM LOAD CONDITIONS, *by E L Tornquist, I L Wade, Public Service Co of Northern Illinois.* The instrument developed to measure these quantities uses a sensitive frequency bridge and watt converter connected in the current and potential metering circuits of the unit under test. Changes in both frequency and kilowatt output are converted into electrical quantities that can be indicated or recorded.

This is done on an oscilloscope with a long-persistence screen. The oscilloscope beam deflects horizontally with frequency change and vertically with kilowatt change. The light beam can be observed for about 30 sec. In this time a rotatable grid can be adjusted to the figure to measure its slope. A camera placed in front of the scope can make a permanent record.

Dead band measured in this manner does not conform to that defined in the AIEE recommended specifications, but is a valuable index of machine and governor performance under load conditions. To measure true dead band, which is largely independent of turbine characteristics, an electronic amplification of governor-valve movement is used instead of the watt-measuring equipment. Prime value of this measurement is in checking purchase specifications. Equipment mounted on the governor valve can be moved to other parts of the governor system to track down lost motion. *AIEE paper No. 49-290.*

COAL HANDLING

PHILADELPHIA ELECTRIC CO ADOPTS MOBILE COAL-HANDLING EQUIPMENT, *by E C Russell, supervisor, Coal Bureau and Steam Heating Div, Philadelphia Elec Co.* Mobile coal-handling equipment is held ideal by the author's company for their conditions and methods of operations. It is their opinion that the equipment is much more versatile than the former system.

In March 1946, the first mobile unit went into service and others followed within a year. They were heavy earth-moving machines designed for construction work, self-propelled, bottom-loading, scraper-type, with four pneumatic tires. They can carry their load at fair speeds up 10% grades.

All the parallel railroad track, such as characterized the locomotive crane coal-moving system in Fig. 3, came out. With the parallel piles with tracks between, Philadelphia Electric could put in about 150,000 tons in storage in Fig. 3. With the tracks out and with mobile coal-handling equipment, coal pile looks like Fig. 4. This is only partly filled and there are 180,000 tons in storage.

Coal piles can be much higher with mobile equipment. Scraper-type equipment allows laying down coal in thin layers. The large pneumatic tires pack coal down to a density of 60 to 69 lb per cu ft.

On the reclaiming cycle the top of the pile is scraped off, leaving the pile in shape for restocking coal. One tractor takes care of loading two scrapers on the shorter hauls, while on the longer hauls three machines can be used.

Where possible the piles should be laid out with ultimate tonnage in mind. Top of pile should be made as small as possible and yet allow sufficient maneuverability for mobile equipment. *ASME paper No. 49-A-63.*

STORING AND RECLAIMING COAL WITH EARTH-MOVING EQUIPMENT AT THE OSWEGO STEAM STATION, *by J Norton Ewart, chief mechanical engineer, Buffalo Niagara Electric Corp.* At the Oswego Station of the Central New York Power Corp over 3 billion-ton feet of coal have been handled during its first nine years of operation. One coal pile reaches 100-ft height in places, yet there has been no danger of spontaneous combustion.

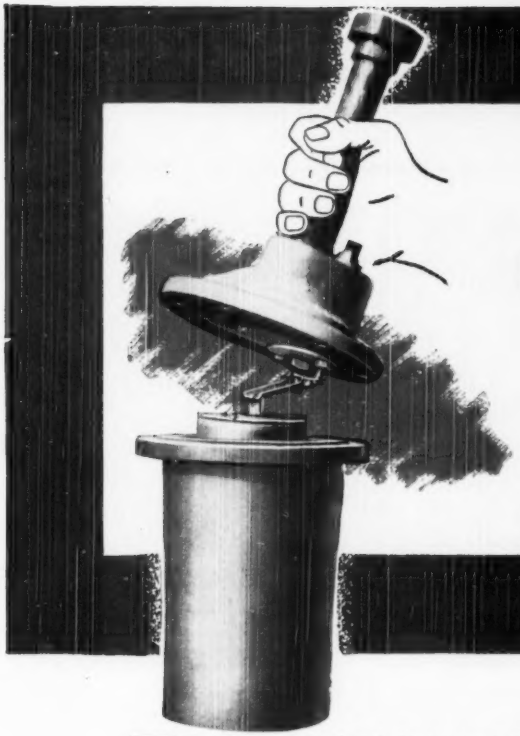
The coal storage extends over an area of 1400 ft long by 400 ft wide. At times the pile has held as much as 560,000 tons of coal.

Coal goes into storage from the discharge of a self unloader or from the stocking pile entirely by bulldozer-carryall units. During stocking a bulldozer-carryall makes a round trip of about 2000 ft every 10 minutes.

This trip starts at the stocking pile where carryall picks up a 13-ton load, and carries it an average of 700 ft to the spreading area. Here it lays down a ribbon about 13 ft wide, 40 ft long, 10 in. thick. Subsequent trips pack this ribbon down to densities reaching 70 lb per cu ft.

No effort is made to avoid segregation although coal is purchased from 60 mines, varying in volatile content from 17 to 30% and sized from fine slack to double screened and run of mine.

(*Continued on page 166*)



"You rarely have to repair this steam trap mechanism"

YOU SAVE TIME AND MONEY

THE Armstrong hardened chrome steel valve opens wide and closes tight — with a snap! This eliminates throttling and consequent wire drawing. The Armstrong free-floating lever mechanism is almost frictionless. The bucket and valve lever assembly are 18-8 corrosion resistant stainless steel. The mechanisms of Armstrong steam traps for low and medium pressures are identical in materials and workmanship to those used in Armstrong traps for pressures to 1500 psi, 900 F.

There is nothing in an Armstrong trap to bind, stick, collapse or leak. *Now is the time to quit working for your steam traps and buy the traps that will work for you.* Call your nearby Armstrong representative today.

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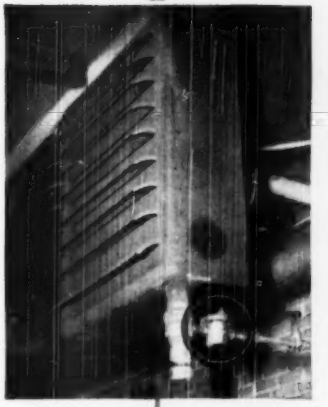


50% SAVINGS IN MAINTENANCE since installing Armstrong steam traps on the heating system at *John Deere Ottumwa Works, Ottumwa, Iowa.* This is typical of reports from Armstrong users.

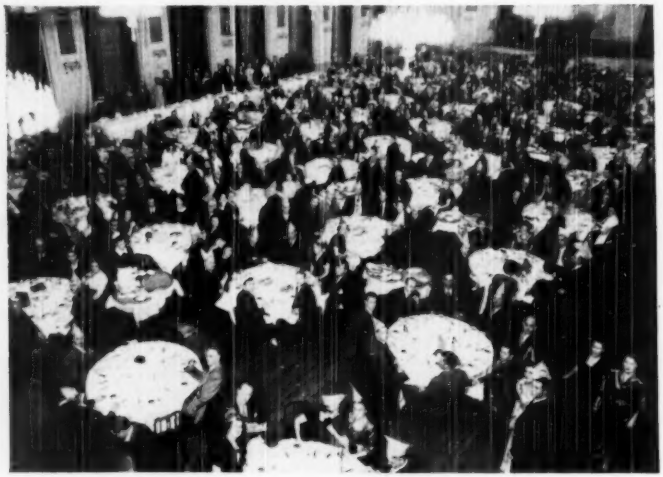
THE 36-PAGE ARMSTRONG STEAM TRAP BOOK contains complete data on the design, operation, selection and installation of Armstrong steam traps for all services. Send for your free copy.

ARMSTRONG STEAM TRAPS

POWER NEWS

BUSINESS ITEMS • APPOINTMENTS • FOREIGN FIELDS
WASHINGTON NOTES • NEW DEVELOPMENTS • CONVENTIONS

JAMES C BUCHANAN, Dominion president of Institute of Power Engineers, 1950



SOME OF 650 MEMBERS and guests who attended Institute of Power Engineers' banquet given during the 4-day convention and the attendant Canadian Power Show

Power Engineers of Canada Put on Snappy Convention

► WITH THE ROYAL YORK HOTEL, Toronto, as headquarters, the Institute of Power Engineers of Canada held its most successful convention jointly with Canada's Power Show. Nearly 1500 members and guests attended. For four days, Nov 28 to Dec 1, activities continued from morning to late evening. These included seven technical sessions, three luncheon meetings, two banquets, and an evening devoted to the moving pictures, "Steam for Power," by Babcock-Wilcox & Goldie McCullough, Ltd, and a "Study of Light" by the Canadian General Electric Co.

The Power Show, also at the Royal York, was the largest ever held in Canada. Over 50 exhibits, representing about 150 different manufacturers, displayed and demonstrated a wide range of power-plant equipments. These included a 75-kw diesel-engine-driven generator set, boilers, several designs of stokers, coal pulverizers, oil burners, flyash and cinder eliminators, smoke-density indicators and recorders, automatic combustion controls, indicating and recording meters, pumps, also feedwater-heating, treating and associated equipment; valves and traps, refractories and heat insulation, mercury-arc rectifiers, transformers, motors and their controls, belts, gears and couplings.

Monday, Nov 28, technical sessions were devoted to smoke abatement and stack-emissions control. Carl Stockman, plant engineer, Eastman Kodak Co, told how efficient plant operation was one of the most important factors in stack-emissions abatement. He emphasized need of meters for (1) keeping reliable records (2) intelligently operating a boiler plant.

At the affiliated engineering societies luncheon, Professor E A Allcut, University of Toronto, and chairman of the advisory board on smoke abatement in Toronto, reviewed the work in smoke abatement in Canada and the United States. He stressed the needs of en-

(*Continued on page* 198)

COMING EVENTS

Jan 30-Feb 3—American Institute of Electrical Engineers, annual meeting, Statler Hotel, New York. R S Gardner, AIEE, 29 W 39th St, New York 18, N.Y.

April 5-7—Midwest Power Conference, Sherman Hotel, Chicago, Ill. Dr R E Whitehead, secy, Illinois Institute of Technology, 3300 S Federal St, Chicago 16, Ill.

April 10-12—American Society of Lubrication Engineers, Detroit, Mich. W F Leonard, secy, ASLE, 343 So Dearborn St, Chicago 4, Ill.

April 12-14—American Society of Mechanical Engineers, spring meeting, Statler Hotel, Washington, D.C. O B Schier, ASME, 29 W 39th St, New York 18, N.Y.

April 19-20—American Institute of Electrical Engineers, Power Conference, Statler Hotel, New York, N.Y. R S Gardner, AIEE, 29 W 29th St, New York 18, N.Y.

May 21-25 — Smoke Prevention Assn of America, Mount Royal Hotel, Montreal, Can. A E McGruer, chairman, Mount Royal Hotel, Montreal, Quebec, Canada.

A Nalco Representative checks over one of "his" plants with the plant engineer. Specialized training and experience make Nalco men your staff consultants on all water treating problems in your plant.

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for Your Plant with

THE *Nalco* SYSTEM

WATER treatment security for your plant—as Nalco interprets it—means that aside from routine testing, control, and required inspections, you can stop worrying, *permanently* about steam purity, scale, corrosion, or other difficulties which might be caused by faulty water treatment procedures and chemicals. The Nalco System goes beyond a cursory survey and an order for chemicals. Your plant becomes the personal responsibility of your Nalco Representative; and he is backed by the entire facilities and personnel of the National Aluminate Corporation — nearly 600 skilled individuals who believe that effective industrial water treatment is up to Nalco standards only if each Nalco System plant is getting exactly the right treatment for the specific water, equipment and operating conditions involved. A postcard or letter will bring you further details on Nalco Water Treatment Security... Check on it today.

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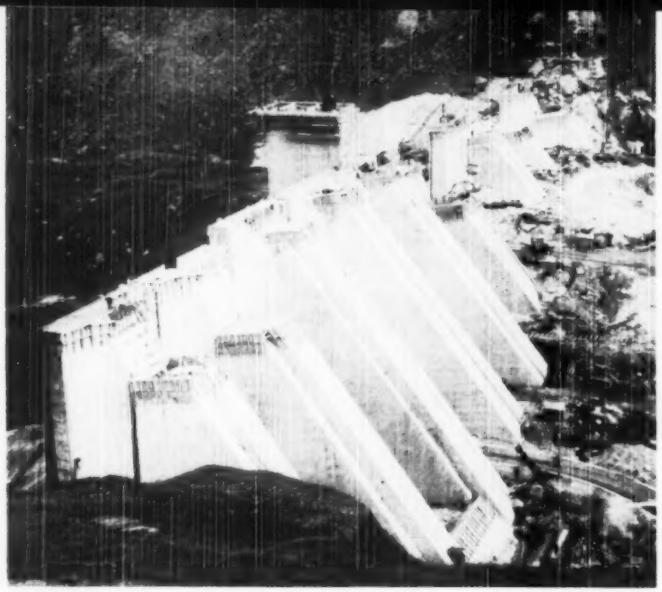
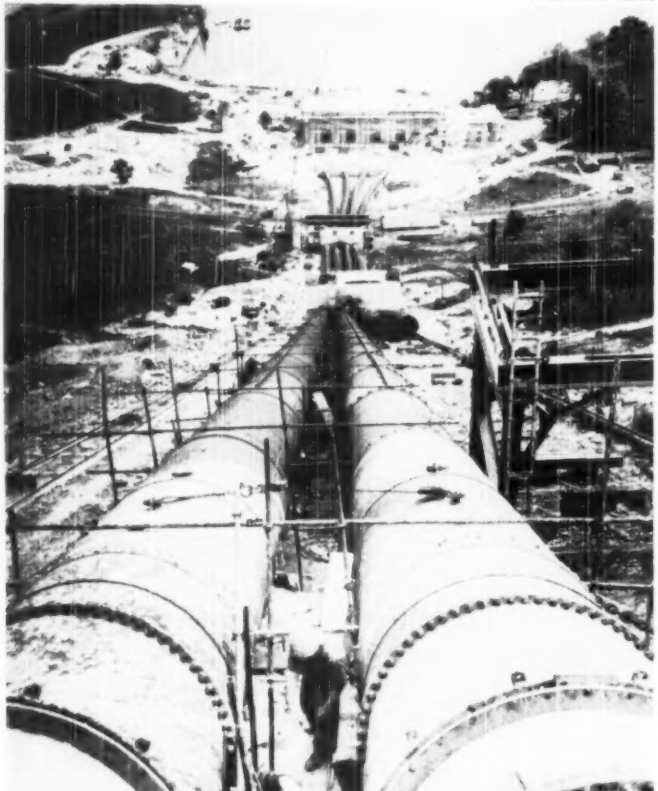
Water Power From the Bonnie Hills Of Scotland



DAM BEING BUILT. Loch Sloy power-generation dam of concrete buttress design will be 1160 feet long and 165 feet high, the second highest in Great Britain

Wide World Photos



PENSTOCK CONSTRUCTION. Two of the four 84-in. plate-steel penstocks leading down to the power house where four 45,000-horsepower turbines will be installed

► A POSTWAR PLAN to produce electrical energy will develop water power in north Scotland. The North of Scotland Hydroelectric Board, a nonprofit corporation, is directing the work.

Development Program. The Board has considered developing over 100 hydroelectric projects estimated to generate 6.25-billion kwhr a year. Parliament has sanctioned 11 projects of 29 that have reached advanced design stages. The 29 will generate about 2-billion kwhr annually.

Largest Project. Largest and first to be constructed is Loch Sloy, about 39 miles from Glasgow. Now nearing completion, the project is in an area of high average rainfall, 115 to 120 in. annually. Development includes construction of a dam 1160 ft long by 165 ft high from lowest point in its foundation. It contains 192,000 cu yd of concrete.

From the dam, a horseshoe-shaped tunnel 15 ft, 4 in. high runs through a mountain for $1^3/_4$ miles. Near the downstream end, the tunnel connects into a concrete-lined vertical shaft 26 ft in diameter, cut into mountain rock and leading to a surge chamber, also in rock.

At the surge-chamber connection, the tunnel divides into two sections, each 10 ft in dia and 500 ft long. These connect to four 84-in. plate-steel penstocks that lead to the power house. When the reservoir back of the dam is full, static head on the plant will be 910 ft.

Power Units. Four 45,000-hp 420-rpm vertical-shaft reaction turbines, with stainless-steel runners, are being installed in the plant. Each unit connects to a 32,000-kw generator. English Electric Co built turbines and generators.

Pressure Regulators. Because of the high head under which the turbines operate, they have pressure regulators, automatically actuated by the speed governors. If load drops suddenly, governors open the bypass valves which close slowly to prevent water hammer and surges in tunnel and penstocks.

Acres of Diamonds

YOU SEE only the structures of commerce, soaring skyward . . . the strange new shapes of industry stretching beyond. Yet all around you are acres of diamonds. Diamonds that identify the thousands of Jenkins Valves on duty in the many different types of buildings essential to modern civilization.

Nothing holds its value like the diamond, in valves as in gems. Four generations of American builders have placed their trust in the Jenkins diamond and signature trade mark. Today, as in 1864, Jenkins Valves are the choice of men who plan shrewdly, always with an eye to future maintenance and operating costs.

They know that Jenkins builds extra endurance into Valves — proved by long life and low upkeep cost records in every type of service. They know, too, that there is extra value in the *experience* Jenkins Valve specialists can apply to any question of selection, installation, or maintenance.

You pay no more for Jenkins Valves, despite their superior quality and service. So why not let the Jenkins diamond serve as your guide to valve economy . . . for new installations, for all replacements. *Sold through leading Industrial Distributors everywhere.*

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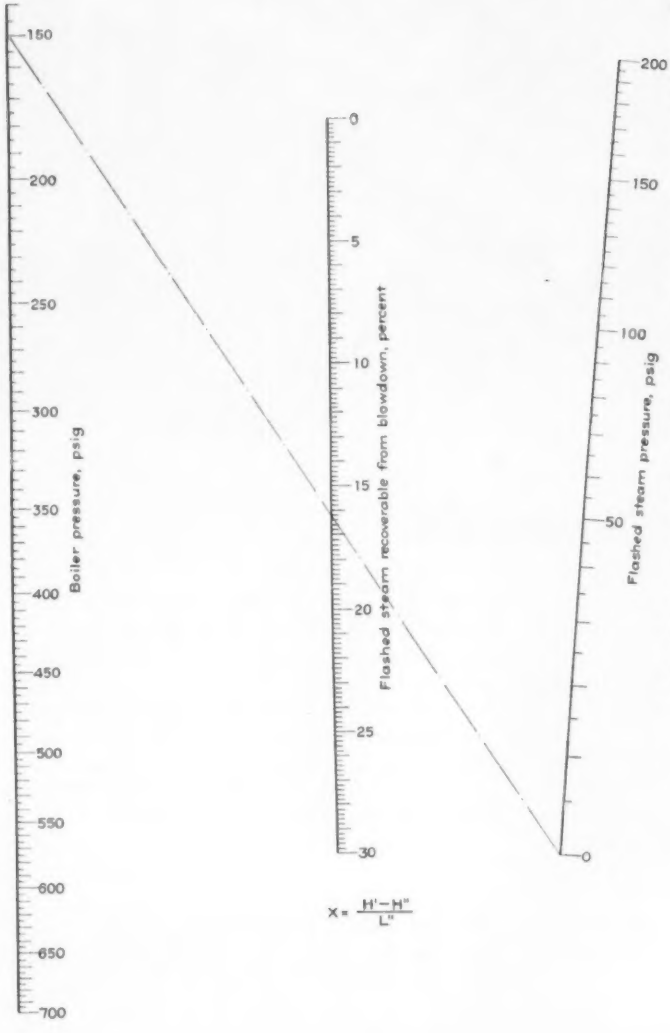
TRADE JENKINS MARK

POWER'S DATA SHEETS

Number 212

Blowdown Flash-Steam Recovery



► When blowing down a boiler continuously, the water can be led to a flash tank that maintains a lower pressure. A certain portion of this water flashes to steam, which can be used for heating in the plant cycle, or to drive low-pressure auxiliaries. Remainder of the water then discharges to waste, carrying with it the solids from the boiler drum. Proportion of blowdown recoverable as steam depends on both the pressures in the boiler drum and in the flash tank. The lower the flash-tank pressure, the more steam can be salvaged.

The nomogram will help to find quickly the amount of steam produced per lb of blowdown for any given pressures.

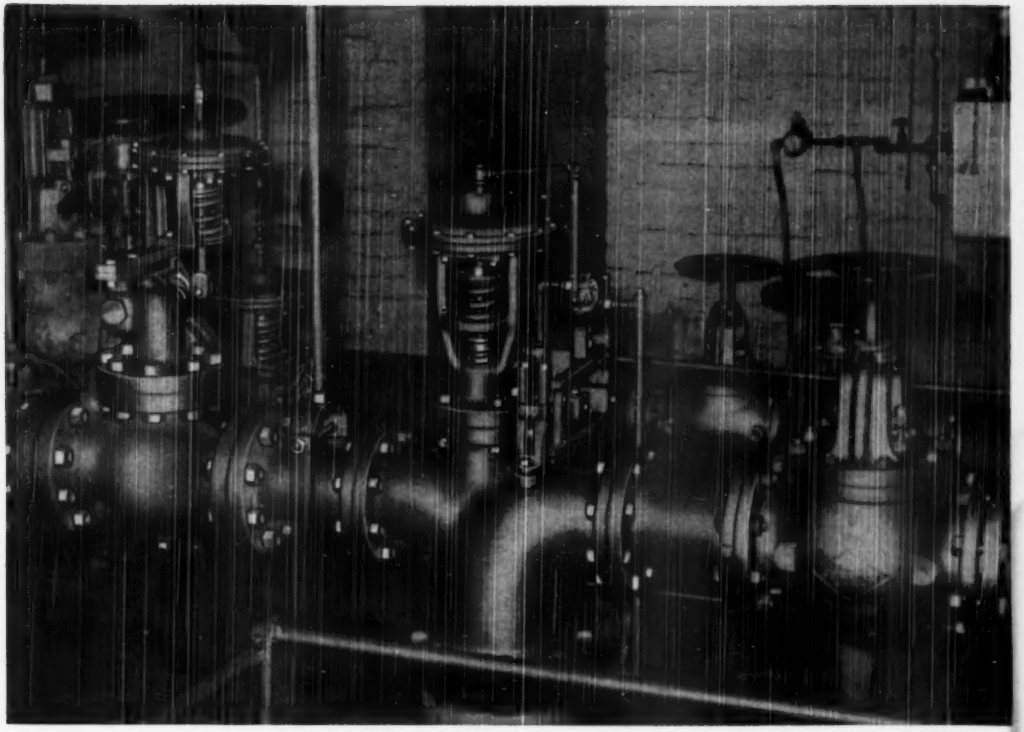
Example: Find the percent blowdown flashed to steam when taken from a boiler running at 150 psig and throttled to atmospheric pressure, 0 psig, in a flash tank. Lay a straightedge between the two values on the outer scales and read at the intersection with the middle scale, 16.3%.

Let's check this by figuring from the steam tables. The two pressures are equal to 164.7 and 14.7 psia. Blowdown enthalpy leaving the boiler is 338.3 Btu per lb. Enthalpy of saturated water at 14.7 psia is 180.1 Btu per lb and the vaporization enthalpy is 970.3 Btu per lb. Letting x be the proportion of one lb of water flashed to steam it's easy to set up the formula at the bottom of the nomograph. Then substituting,

$$x = \frac{338.3 - 180.1}{970.3} = 16.3\%$$

This checks the answer from the chart.

John F Hyam *Sarnia, Ontario*



Close, quiet control of reduced steam pressure and temperature

When it comes to your pressure reducing and desuperheating station, you will find COPES engineers talk your language. They design and size your station to give precise, noise-free control for years to come.

IN THE PICTURE . . .

COPES Pressure Reducing and Desuperheating Station handles up to 25,000 pounds of steam per hour from 450 psi and 509 F to 220 psi saturated. Pressure and temperature are held within close limits demanded for efficient operation of process equipment.

Thus you avoid high velocities, vibration, "chatter" and wear. Your final pressure and temperature are not upset by "hunting"—but hold within the limits you specify.

Your reducing valve has a high lift to equalize wear over more of the piston area, increasing service life. Your Desuperheater completely atomizes the cooling water, even at the lightest flows.

Bulletin 477 tells the story of these accurate, *quiet* controls. Write for your copy—now.

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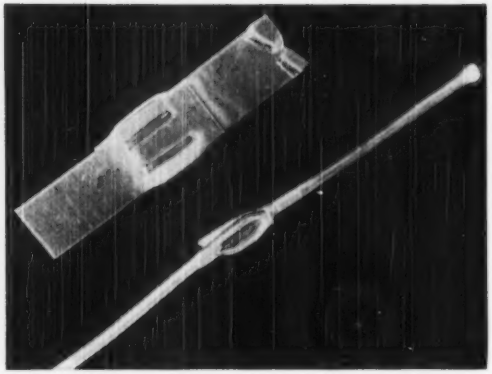
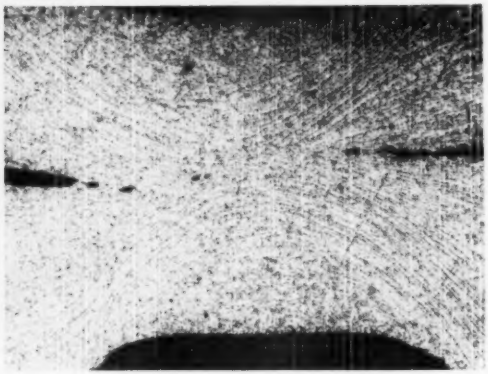
Your information center for new products to solve plant problems. Spot what you need, use handy cards to request more details





Two examples of finished welds carried out by the new cold-welded process shown above. The weld comes about by simply squeezing pieces together with properly shaped dies. Etching, right, above, shows that metal flows together in a true bond

HERE'S SOUND WELDING BY COLD PROCESS

P201 • Sensational new process, recently developed by the General Electric Co Ltd, of England, welds nonferrous metals without heat, adhesives or chemicals, merely by squeezing them together with properly shaped dies. Metals so far successfully cold-welded include aluminum, duralumin, cadmium, lead, copper, nickel, zinc and silver.

Procedure is extremely simple. With aluminum, for example, the contact surfaces are wire brushed for a few seconds. Parts are then lapped and squeezed between dies designed to produce properly shaped indentations on both sides. The welding is then complete.

In the cold-pressure process of welding, the metal is made to flow *away* from the welding point. It seems that this flow carries away the last trace of oxide, permitting a true molecular bond. Exact shape of the tool is an essential part of the process.

Three techniques so far evolved include the straight weld, the ring weld, and the continuous seam weld. The straight weld can be used for box seams, for sealing tube ends, and for other forms of lapped joints that are almost equivalent to butt-welds.

The ring weld can be used to seal the end of a flanged tube, to join a flanged tube to a plate, or to join two disks at edge to make an air-pressure cell.

The seam weld has many applications for tube making and for sheathed cables.

Coldweld Corp, 10 E 40th St, New York 16, N. Y.

HIGH-SPEED REAMER **P220**

Standard and special high-speed reamers are now made with high-cost high-speed steel firmly secured in recesses of low-cost low-carbon steel-tool bodies.

Rolling process under the *Palm* patent involves no application of heat as in welding and brazing, to deteriorate temper, hardness and durability of cutter blades. Standard reamers are available up to 6-in. dia. Step reamers and specials can be built to specifications.

Halsey Products Co, 29706 Grand River Ave, Farmington, Mich.

TRASH PUMP **P206**

Pumping unit handles trash and has impeller without vanes or blades on which trash or other fibrous material can catch. Impeller is like a corkscrew. The curved channel starts with a small radius at the axis of rotation and fans out in a helical path. Thus, centrifugal action throws the fluid against the side of the discharge channel.

Because the channel sides slant forward, the fluid carrying with it solids and trash is driven along the channel. At its suction end the channel has the same diameter as the inlet pipe, so almost anything that can enter the pump will be carried through without clogging. Pumps are available in sizes of 2- to 5-in. suction.

Fairbanks Morse Co, 600 S Michigan Ave, Chicago 5, Ill.

DUST COLLECTOR **P224**

Self-cleaning paddle-wheel fan driven by a 5-hp motor removes dust, lint, shavings from industrial processes into *Model 30 N 50 Dustkop* dust collector.

Air velocity reaches 10,400 ft per min to pull 3630 cfm. Model takes up 28x49 in. floor space and stands 82 in. high.

Aget-Detroit Co, Ann Arbor, Mich.

RESISTANCE METER **P249**

Vibropot pushbutton-operated instrument is an accurate dc ohmmeter and ac impedance bridge, as well as an instrument applicable for earth-resistivity measurements. Suitable for testing resistance to earth of man-made grounds.

Associated Research, Inc, 3758 West Belmont Ave, Chicago 18, Ill.

GAGE **P235**

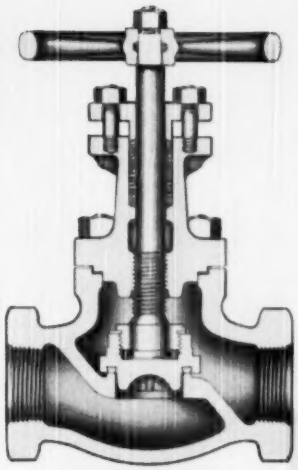
Illuminated gage has dial, with black blackground with ultraviolet phosphorescent pointer, numerals and graduations. Plain white illumination can also be supplied. Gage comes in standard 4½-, 6- and 8½-in. dial sizes.

Helicoid Gage Div, American Chain & Cable Co, Inc, Bridgeport 2, Conn.

(Continued on page 148)

For further data on above items use reply cards on page 192a, identifying your request with letter P and number

ALL PIPING EQUIPMENT YOU NEED ...FROM ONE SOURCE OF SUPPLY



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For volatile and hazardous fluids, these valves are supplied with a lead face disc specially designed for tight seating. For high temperatures and certain corrosive conditions, a case-hardened steel disc and seat can be supplied. Available with tongue and groove flanged ends, or screwed ends with extra long threads, and recessed for soldering. See your new No. 49 Crane Catalog, p. 394-5.

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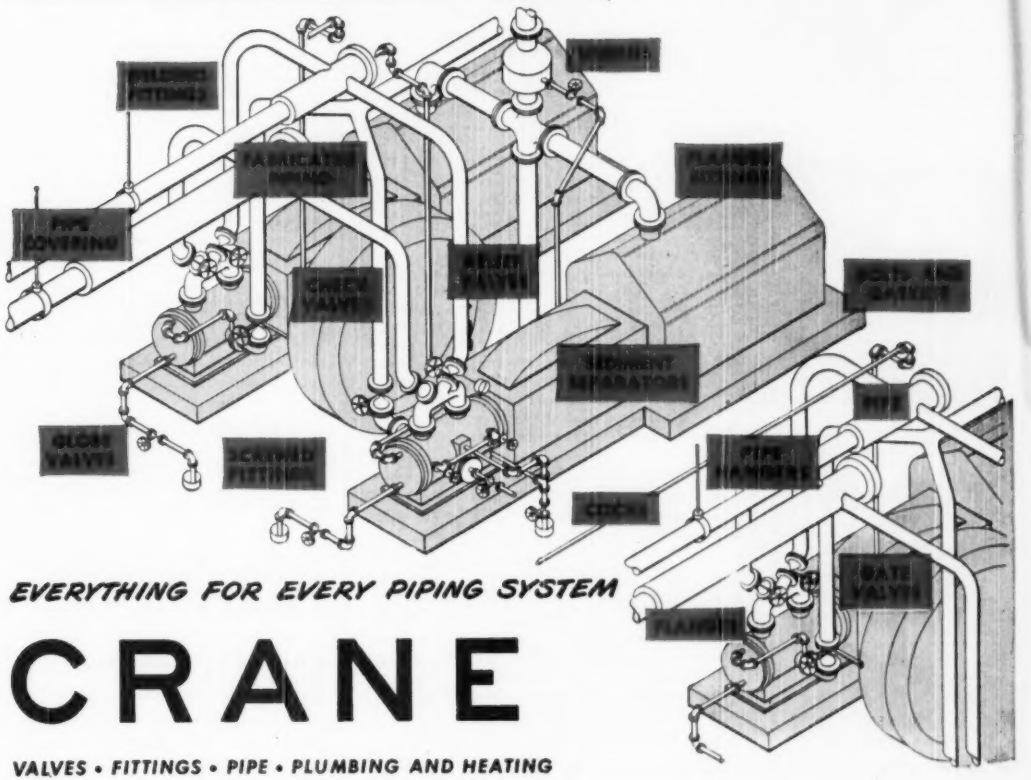
WORKING PRESSURES:
300 pounds ammonia;
500 pounds oil, gas, or air up to 100° F.
Sizes: ¼ to 3 in.; Screwed or flanged ends.

THIS AMMONIA COMPRESSOR INSTALLATION, FOR EXAMPLE, CAN BE COMPLETELY EQUIPPED BY CRANE



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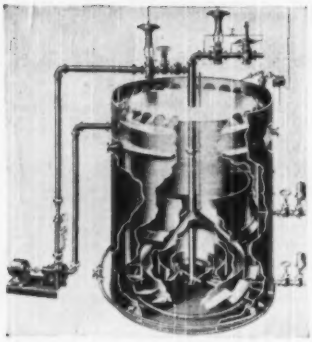
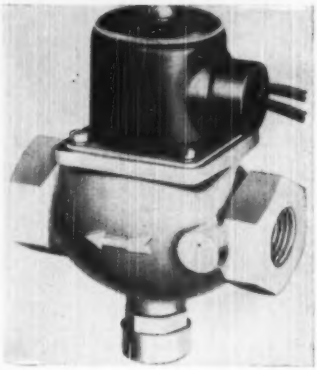


WATER SOFTENER **P236**

Cold-process slurry-type precipitating softener and coagulator employs hydraulic energy for mixing the applied chemicals with previously formed precipitate.

Flocculation occurs without the need of submerged mechanical moving parts. Complementary recirculation of treated water maintains a uniform depth of slurry bed independent of load. Density of slurry is automatically maintained.

Where filters are used for final clarification, a washer reclamation compartment is incorporated so filters can be economically backwashed with clean, chemically inert water without imposing increased flow rates. **Worthington Pump & Mach Corp, Water Treating Section, Dunellen, N. J.**



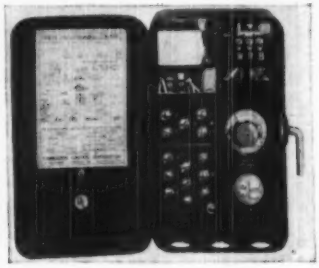
GAS VALVE **P240**

Series 3500 solenoid gas valve is designed for space heaters, furnaces, central-heating equipment, conversion burners, etc.

Closing pressure is achieved by the combined force of (1) compression spring, pushing down on the plunger, (2) plunger assembly, which is heavier than that of ordinary solenoid valves and (3) pressure of the gas itself. Positive shutoff is assured by a seat of special synthetic material, unaffected by heating gas.

Valve is available in ½, ¾ and 1 in. sizes, with or without manual opening device. Low-voltage models are furnished with a transformer fully protected by a built-in thermal overload switch. Valve is AGA listed.

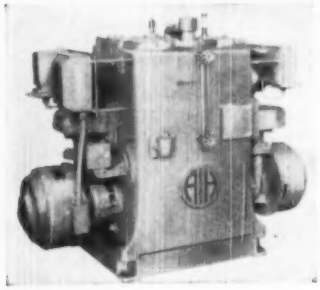
Perfex, Corp, Milwaukee, Wis.



PROGRAMING CONTROL **P221**

Automatic starting and programing can be achieved for commercial gas and oil burners with the *Fireye 24PJ8*.

The control automatically starts the burner and programs the sequence of fuel-valve opening, post-ignition timing, priming and scavenging. It is used with electronic flame rod, *45JQ1*, or photoelectric scanner, *45PH5*, for continuous safeguarding against flame failure. A high-torque synchronous motor drives the timing cams. **Combustion Control Corp, 77 Broadway, Cambridge 42, Mass.**



VACUUM PUMP **P245**

Combination condensate-return and vacuum pump, *Model VE*, has one centrifugal pump for both functions with no close-fitting revolving parts.

Vacuum is produced by use of a water-jet venturi system. All parts are easily accessible in the cast-iron unit. Bronze fittings apply throughout. It is sealed against air in-leakage with mechanical seals. Available in single and duplex models from 5000 to 25,000 edr.

American Hydrovac, Dept PH, 290 Scholes St, Brooklyn 6, N. Y.

(*Continued on page 150*)

Don't Miss...

. . . Test Fixture that mounts on bench for checking hose assemblies, piping, tubing, gages and valves. Equipment consists of low-pressure pumps for filling equipment, a 3-gal reservoir, a high-pressure pump page 192

. . . Control Valve designed primarily to handle corrosive fluids, gases or slurry or fluid-carrying solids in suspension. Packless valves are used and flow characteristic is substantially linear page 182

. . . Water Softener of the new-process slurry type. It applies a hydraulic force for mixing the applied chemicals with a previously formed precipitate. Flocculation occurs without any submerged mechanical moving parts page 148

. . . Chemical Feeder Control that provides an adjusted output from a chemical feed pump. Volume is controlled by varying the pump displacement from zero to full page 202

. . . Centrifugal Pump with a 2-stage volute design in capacities ranging up to 825 gpm and heads to 800 ft. It has a watercooled, duplex, angular-contact thrust bearing page 186

. . . Hydraulic Control that allows adjustment of output speed of a motor-driven variable-speed transmission. Control can automatically regulate tension, speed, pressure, temperature, liquid level page 188

. . . Arc Welder with a generator whose welding range goes from 40 amp at 20 v to 250 amp at 40 v. page 204

. . . Combination Motor Starter and circuit breaker for controlling polyphase motors from 1 to 100 hp. This combination incorporates several new safety features page 204

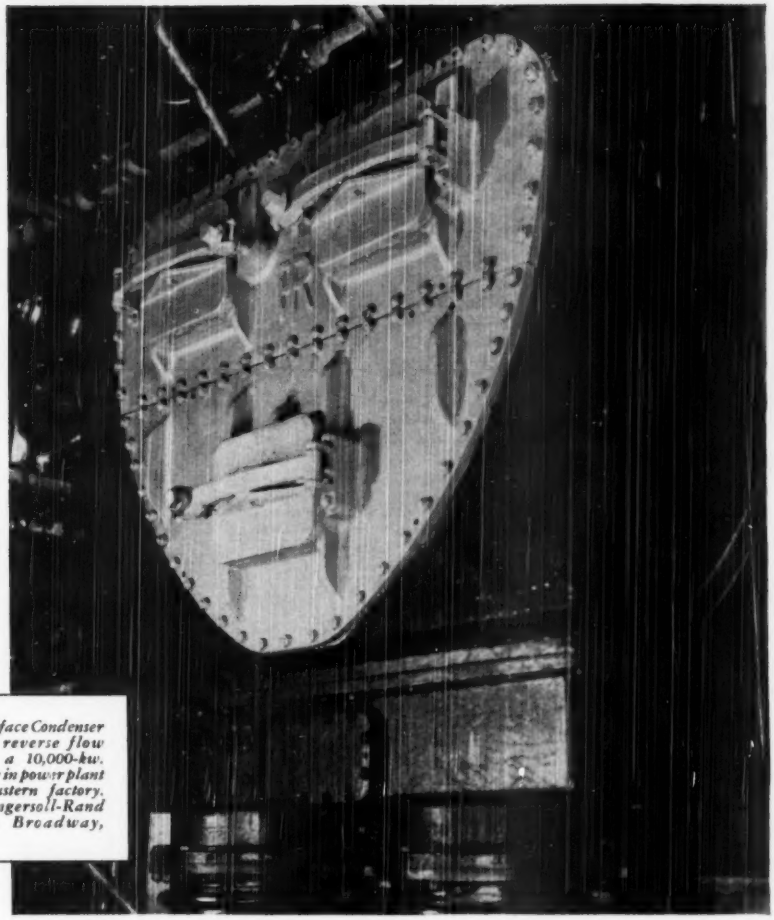
. . . Transformer Loading Relay that operates when transformer loads get beyond normal self-cooling ratings. With it you can turn on cooling fans or sound alarms page 184

. . . High Range Megohmmeter designed for electrical-resistance measurement over a range from 300,000 to 20,000,000 megohms page 190

And Next Month...

Quick Steamer that can develop full working pressures in less than two minutes in sizes from 75 to 600 psi.

For further data on above items use reply cards on page 192a, identifying your request with letter *P* and number



A Two-Pass Surface Condenser with built-in reverse flow valve, serving a 10,000-kw. turbo-generator in power plant of a large Eastern factory. Photo from Ingersoll-Rand Company, 11 Broadway, New York.

This heart must NOT beat!

● This heart-shaped condenser must stand solid as a rock, silent and unmoving, if its tubes are to serve out their appointed time. Yet it is sometimes true that changed conditions, or the operation of other machinery, will produce damaging vibration in a condenser, no matter how perfectly it was originally designed, built and installed. The good old test of the palm of your hand against the condenser shell is not adequate; tiny unfelt quivers may be shortening tube life. Vibration accelerates corrosion in several ways. The alternating stresses in time produce cracks across the grain of the metal, weakening it and giving corrosive elements new points to attack. Vibration may also disrupt or disturb the thin film on the surface of the metal that protects it and helps reduce the rate of corrosive attack. Of course vibration is but one of a number of factors affecting the service life of condenser tubes, and so when tube life becomes short we always suggest that samples from failed tubes be sent to us. If vibration is a factor, microscopic examination will show it. Other influences will be sought, and in the end we may be able to make suggestions that should materially extend the time between re-tubings, restoring the condenser to the original efficiency. Why not use our know-how as well as our tubes and tube plates?

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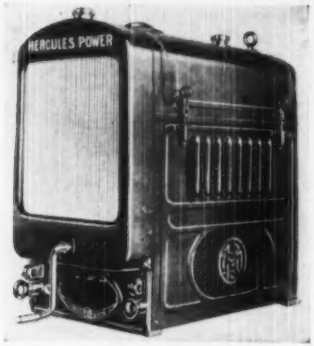
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere.

EQUIPMENT NEWS *CONTINUED*

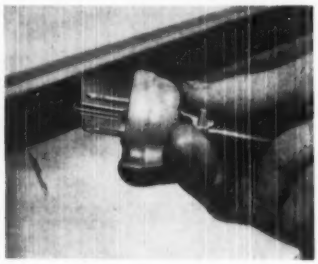


POWER UNITS **P202**

Three 4-cylinder gasoline-engine power units complete an extensive line ranging from 39 to 935 cu in. displacement. Companion diesel-engine power units range from 127.5 to 935 cu in. *Model JX4E* is 3½x4¼ in. for a displacement of 164 cu in.; *Model JX4C* is 3¾x4¼ in. and 188 cu in.; *Model JX4D* is 4x4¼ in. and 214 cu in. They are designed for high-speed heavy-duty service wherever portable power can be used to advantage and are available in open, closed or base-type mountings.

Engines have five main bearings; crankshaft is counterbalanced and *Tocco* hardened. Combustion chamber in cylinder head has high-turbulence design. Exhaust valves feature austenitic heads welded to hardened nickel-steel stems. Full-length water jackets are provided, with intake and exhaust valve passages designed for maximum cooling of valve seats and steam.

Hercules Motors Corp, Canton, Ohio



PLUG-IN WIRING STRIP **P252**

In addition to providing a spread of electrical outlets at either 6- or 18-in. intervals, new multi-outlet assembly allows plugging-in grounded or ungrounded portable electrical equipment in every receptacle. Besides conventional two slots in each receptacle, there is an adjacent third grounding slot.

Type *CF2-G* strip has a 24-gage steel channel to handle two No. 12 insulated conductors. Complete installation is made by joining 6-ft standard lengths of strip.

National Electric Products Corp, Chamber of Commerce Bldg, Pittsburgh 19, Pa.

TIMING RELAY **P248**

Pneumatic relay with synthetic-rubber bellows for controlling tripping time. Available for ac or dc application, relay's range is easily adjustable from 10 cycles to 3 minutes with an accuracy of ± 10%.

Relay resets instantaneously. Performance is unaffected by temperature, humidity or vibration.

Allen-Bradley Co, Milwaukee, Wis.

SOLDER ALLOY **P217**

Hard-type low-melting, high-strength *Eutecrod 192*, solder alloy, joins aluminum to steel, bronze and copper as well as aluminum.

New alloy comes in 1/16, 3/32, ⅛ in. coil forms. It is recommended for sealing cracks, spot welds, and general aluminum soldering. Bonding temperature is 650-700 F; tensile strength is 11,000 psi.

Eutectic Welding Alloys Corp, 40 Worth St, New York 13, N. Y.

ROLLER CHAIN **P251**

BA assembly consists of a 5-ft basic length of standard riveted roller chain with a new single-pin connector. Connecting link uses one detachable pin and one rivet.

It is necessary to remove only one pin to disconnect chain. Single-pin connector has a distinctive tear-drop shape for easy identification.

Chain Belt Co, 1600 W Bruce St, Milwaukee 4, Wis.

ALUMINUM BRAZING WIRE **P215**

Greater corrosion resistance, better ability to withstand pressure feature the *No. 718* aluminum brazing wire, brought out by the manufacturer to replace its *No. 716*. The new wire is sold in 3/32- and ⅛-in. diameters. Standard package for coil weighs about 55 lb. The company recommends *Elite* aluminum brazing flux be used in conjunction with the wire.

Air Reduction Sales Co, 60 E 42nd St, New York 17, N. Y.

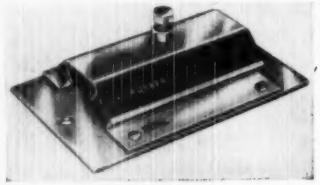
VALVE TOOLS **P237**

Valve seat ring wrenches are made of heat-treated alloy steel. In use, the union bonnet ring of the valve acts as a guide, bearing against a shoulder on the wrench.

Fig. 1652 wrench has a threaded collar that provides for adjustment on different-depth valves. It is designed primarily for bronze *Renewo* and *Ferrenewo* plug-type valve from ¼ to 3 in. *Fig. 1656* wrench is designed for *AAR* plug valves from ¼ to 2 in.

For screw-over bonnet valves, which do not have union bonnet rings, *Fig. 1653* bronze retaining ring holds the wrench firmly in place.

The Lunkenheimer Co, Beekman & Waverly Ave, Cincinnati 14, Ohio



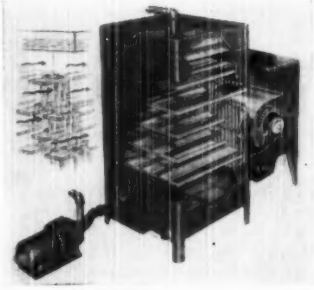
VIBRATION ISOLATOR **P214**

Steel channel floating in rubber between two steel angles, welded to a steel plate for bolting down, make up the *Finnflex SP-9* vibration isolator.

Correct angularity between steel and securely bonded rubber enables the isolator to approximate the flat spot on a stress-strain curve of relative slope. Because the spring index (load divided by deflection) is not constant, resonance is avoided.

When a machine bolts to the top channel of the SP-9 mount, the entire weight is carried by rubber-in-shear. These mounts provide for a specific load varying from 40 to 3000 lb each. *Finnflex SP-9* is available in any length up to 30 in. and in four rubber stiffnesses for loads of 40, 50, 70 and 105 lb per inch of length at ¼-in. deflection.

Finn & Co, 2850 Eighth Ave, New York 30, N. Y.



COOLING TOWERS **P241**

Compact, extra quiet, induced-draft cooling towers, *Type E*, of galvanized steel fit in well with small, packaged, watercooled air-conditioning and refrigeration condenser units.

Warm water from the condenser section of the refrigerating unit goes to a water-diffusion pan on top of the tower. Perforations in the floor of the diffusion pan let

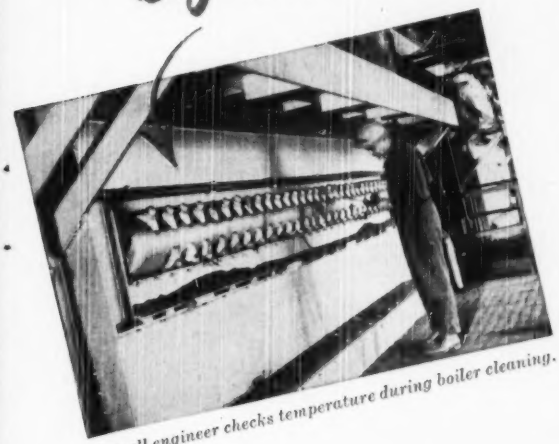
(*Continued on page* 182)

For further data on above items use reply cards on page 192a, identifying your request with letter *P* and number

DOWELL

SERVICE SPECIALISTS IN MAINTENANCE CLEANING PROBLEMS

Big Boiler Cleaned in ONE DAY by Dowell Service!



Dowell engineer checks temperature during boiler cleaning.

Quick, Effective Maintenance Service Cuts Total Down Time in Half

A TYPICAL EXAMPLE of the economies afforded by Dowell Service is reported in the case of a midwestern refinery using five 300,000 lb. per hour boilers to generate electrical power. Before Dowell Service was used in the plant, boilers were usually down two weeks whenever repairs became necessary—during which time electricity was purchased from an outside source. Using Dowell Service to do the internal surface cleaning, the boiler is back in use in one week instead of the usual two! And the Dowell part of the operation takes just one day!

Dowell Service, using the experience of thousands of successful jobs, offers you the solution to maintenance problems of this type. It is backed by strong, continuous research programs, both in Dowell's own laboratories and in those of The Dow Chemical Company. This research provides the means for an improving service with an increasing degree of effectiveness and safety.

When you call on Dowell Service for your maintenance cleaning, experienced Dowell engineers do the job for you. They bring the special equipment—truck-mounted tanks, mixers, heaters, and proportioners—necessary for controlled cleaning. No dismantling or scaffolding is required. Liquid solvents are pumped into the equipment through regular connections. Down time is held to a minimum.

For quick, practical, economical cleaning of boilers, heat exchange equipment, water lines and water wells, call the nearest Dowell office. Free cost estimates gladly given.

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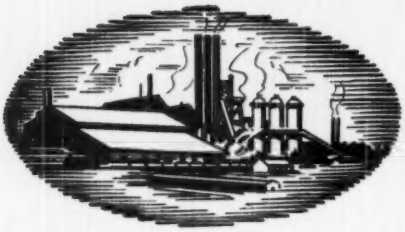
DOWELL

A SERVICE ORGANIZATION



1900 ★ THE MIRACLE OF AMERICA ★ 1950

Freedom and Progress

It's no stretch of the imagination, rather, robust realism to call our past half century a Miracle—U. S. A.

America has set an amazing record of progress in 50 years—but a moment in the history of civilization. A record unequalled by any other political or economic system.

Merely by broad brush strokes, we can all visualize this miracle. Remember the crystal set, the hand-cranked car, the biplane? A far cry from our FM radio, television, hydro-matic drive and supersonic planes.

And here's another phase of the miracle that went hand-in-hand with these and the myriad of intertwined technological advances—ranging from the radio telephone and Bakelite to the X-ray tube and teletype . . . and to atomic energy and its untold potentialities.

- ★ Since 1900 we have increased our supply of machine power 4½ times.
- ★ Since 1900 we have more than doubled the output each of us produces for every hour we work.
- ★ Since 1900 we have increased our annual income from less than $2400 per household to about $4000 (in dollars of the same purchasing power), yet . . .
- ★ Since 1900 we have cut 18 hours from our average work week—equivalent to two present average workdays.

How did we do it? The basic cause for this composite miracle has been the release of human energy through FREEDOM, COMPETITION and OPPORTUNITY. And one of the most important results is the fact that more people are able to enjoy the products of this free energy than in any other system the world has ever known.

THIS IS THE MIRACLE OF AMERICA . . . it's only beginning to unfold.

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STANDARD OIL COMPANY (INDIANA) Power Plant, serving a refinery at Wood River, Illinois. Built during World War II, it is one of a number of large-scale facilities constructed by Dravo to satisfy the varied power needs of many diverse industries.

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Engineering Constructors of power plants, boiler plants, central stations, compressor stations, water pumping stations—fabricators and erectors of power piping—power and boiler plant equipment.

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ENGINEER'S BOOKSHELF

REVIEWED IN THIS ISSUE

ELEMENTS OF THERMODYNAMICS AND HEAT TRANSFER • STEAM POWER PLANTS HEATING, VENTILATING, AIR-CONDITIONING FUNDAMENTALS • PUMP Q & A FUNDAMENTALS OF POWER-PLANT ENGINEERING • RADIANT HEATING CURRENT RESEARCH AND DIRECTORY OF MEMBERS • METHODS OF JOINING PIPE STEAM, AIR AND GAS POWER • THE COLUMBIA: POWER HOUSE OF THE WEST DE LAVAL ENGINEERING HANDBOOK • THE ELECTRIC POWER INDUSTRY NUMERICAL ANALYSIS OF HEAT FLOW • HEAT POWER FUNDAMENTALS

Heat Transfer

NUMERICAL ANALYSIS OF HEAT FLOW. *By G M Dusinberre, professor of mechanical engineering, The Pennsylvania State College.* 227 *pp, illust, tables,* 6x9¼. $4.50. *McGraw-Hill Book Co,* 330 *W* 42*nd Street, New York* 18, *N. Y.*

By assuming a material completely homogeneous the calculus may be applied in solving problems of heat flowing through it. Many of the methods of calculus originated in the study of heat-flow problems. This is known as the analytical method. However, despite the implied exactness of the mathematical concept, it is only an approximation of the true conditions.

Another approximation represents the material as a finite network of points. The scale of the network exceeds the actual discontinuities between the molecules of the material under study. This method, called the numerical method, can be solved graphically also. Again, though, it can be only an approximation of real conditions.

The book compares the two methods where possible and shows that the disagreement in solutions is negligible in comparison with other uncertainties and assumptions that must be made in applying the methods. Problems of both steady-state and transient conditions are discussed.

The author warns that the book is not adapted to casual reading. The reader who wants to learn a better and newer way of solving heat transfer problems will find here a new tool.

Power-Plant Engineering

FUNDAMENTALS OF POWER-PLANT ENGINEERING (1949). *By George E Remp, asst prof of mech engrg, University of Florida.* 347 *pp,* 5½x8½ *in.* $6.50. *The National Press, Millbrae, Calif.*

Reproduced from the author's typescript by lithography, this book was prepared primarily for use in Prof Remp's own classes. Engineers may find it a useful text for brushing up on fundamentals of steam power.

Using his experience as plant operator and teacher, the author has chosen to start with a study of load curves and power-plant economics. He goes on to an examination of power-plant cycles and basic principles of plant components. There are also chapters on load division, diesel-electric, hydroelectric and gas-turbine power plants.

For study purposes, examples are given throughout and one series of projects is included as an aid to the instructor.

Steam Power Plants

STEAM POWER PLANTS. *By P J Potter, University of North Dakota.* 503 *pp, illust, tables,* 6½x9¼. $6.50. *The Ronald Press Co,* 15 *E* 26*th St, New York* 10, N. Y.

This text is written for elementary courses in steam power-plant engineering and design. From a basic presentation of physical data on fluid flow, methods of designing piping systems are introduced. A résumé of pump construction and operating characteristics lays the groundwork for their application. A brief introduction to heat transfer leads to problems in conduction, radiation and insulation. Typical forms of boilers, heat exchangers, turbines, steam engines, auxiliaries are discussed. Their final integration in a plan is treated in a chapter on heat balance.

Pump Q and A

PUMP QUESTIONS AND ANSWERS (1949). *By Roy Carter, Igor J Karassik, Elliott F Wright, V deP Gerbereux, W C Mumford and Albert M Shaw, pump engineers, Worthington Pump & Machy Corp.* 346 *pp,* 6x9 *in., illust, cloth.* $5. *McGraw-Hill Publishing Co,* 330 *W* 42*nd St., New York, N. Y.*

Here are assembled nearly 700 questions and answers on centrifugal, vertical-turbine, regenerative-turbine, rotary and reciprocating pumps, written by six pump engineers, each an expert in his field. These questions deal with construction, application, operation, installation, maintenance and trouble shooting. They are divided into five major sections, one for each of the types named.

The section on centrifugal pumps describes these units and their parts, divides them into the classifications where they generally fall, and treats of the material used in their construction. Application, installation and maintenance are given a complete treatment along with troubles, symptoms and causes. The final chapter on centrifugals deals with priming, always an important subject.

Sections for the other pump types follow the pattern for centrifugals. Each section has a carefully worked out and exhaustive analysis of the pump's common troubles, their symptoms and causes, and how to correct them.

Of the several books on pumps this is the most practical and useful for those interested in applications and operation. The questions and answers were originally published in POWER over a 3-year period. During that time the editors received hundreds of letters requesting reprints.

Radiant Heating

RADIANT HEATING. *By T Napier Adlam, vice-president, Sarco Mfg. Co.* 504 *pp,* 6x9, *cloth, over* 335 *illust,* 19 *tables.* $6. *Published by The Industrial Press,* 148 *Lafayette St, New York* 13, *N. Y.*

This second edition covers the latest and most important developments in the U.S. and Europe. There are 16 chapters, opening with heating terms most commonly used, with definitions for all.

Material on ceiling panels has been added to include enclosed convector panels, gravity warm-air panels and forced warm-air panels. Chapter on floor panels has been increased to cover research on physiological aspects of heated floors.

Because of the great interest in snow melting and the increased number of snow-melting installations, considerable practical information has been worked in to help those designing such systems.

Back part of the book features 78 working charts for easy direct determination of pipe sizing, covering both iron or steel pipe and copper tubing.

Heat Power

HEAT POWER FUNDAMENTALS. *By C M Leonard, professor of mechanical engineering, Oklahoma Agricultural and Mechanical College, and V L Maleev, professor emeritus of mechanical engineering, Oklahoma Agricultural and Mechanical College.* 596 *pp, illust, tables,* 6½x9. $5.75. *Pitman Publishing Corp,* 2 *West* 45*th St, New York* 19, *N. Y.*

This introductory text in heat power covers fundamentals of energy as used in power equipment. It reviews the general energy equation, thermodynamic laws and the Carnot cycle and relations of elementary thermodynamic properties. Basic principles of steam engines and turbines are examined as well as their associated condensing equipment, boilers and auxiliaries.

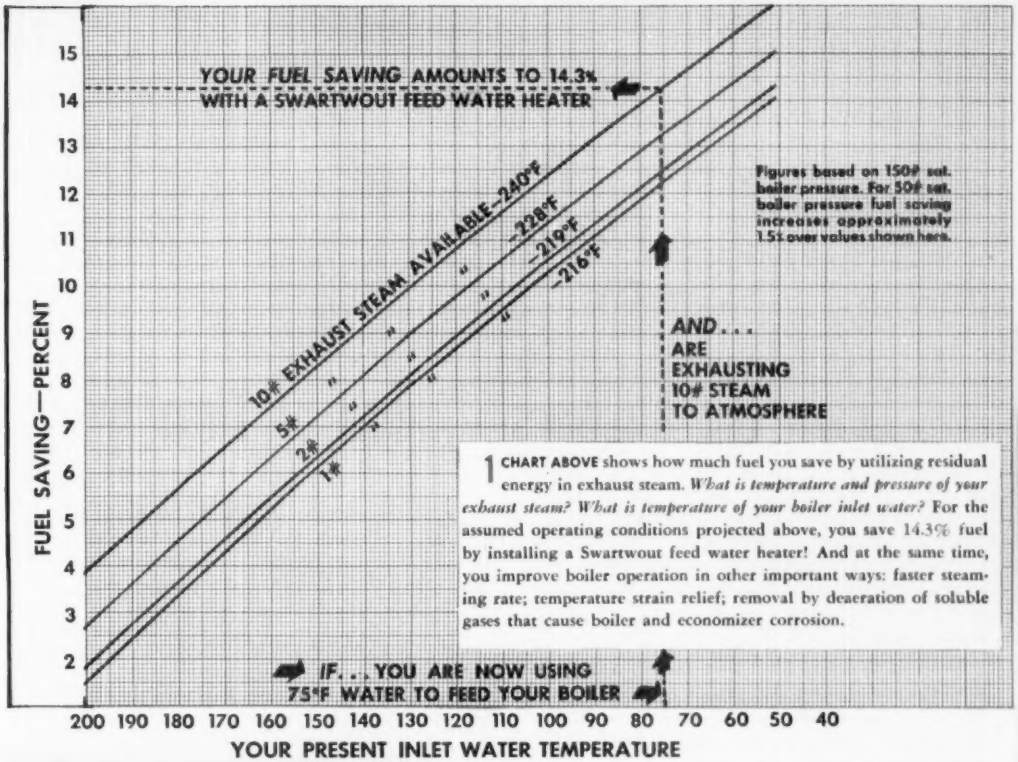
Three chapters are devoted to fuels and fuel-burning equipment and boiler draft systems. One chapter each is devoted to internal combustion engines, gas turbines and refrigeration.

Pipe Joining

METHODS OF JOINING PIPE. *By J E York, building service engineer, Stone & Webster Engineering Corp.* 236 *pp,* 5½x8½, *cloth, well illustrated.* $3. *Published by The In-*

(*Continued on page* 170)

Use exhaust steam! Swartwout feed water heaters save 1% fuel for every 11° temperature rise


FUEL SAVING—PERCENT
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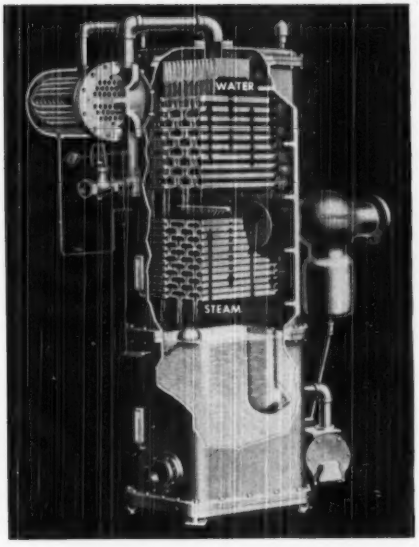
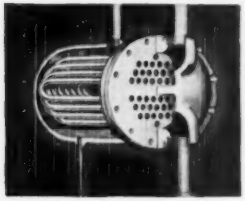
2
YOUR FUEL SAVING AMOUNTS TO 14.3% WITH A SWARTWOUT FEED WATER HEATER
10# EXHAUST STEAM AVAILABLE—240°F
5# " —228°F
2# " —219°F
1# " —216°F
Figures based on 150# sat. boiler pressure. For 50# sat. boiler pressure fuel saving increases approximately 1.5% over values shown here.
AND . . . ARE EXHAUSTING 10# STEAM TO ATMOSPHERE
IF . . . YOU ARE NOW USING 75°F WATER TO FEED YOUR BOILER
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40
YOUR PRESENT INLET WATER TEMPERATURE

1 CHART ABOVE shows how much fuel you save by utilizing residual energy in exhaust steam. *What is temperature and pressure of your exhaust steam? What is temperature of your boiler inlet water?* For the assumed operating conditions projected above, you save 14.3% fuel by installing a Swartwout feed water heater! And at the same time, you improve boiler operation in other important ways: faster steaming rate; temperature strain relief; removal by deaeration of soluble gases that cause boiler and economizer corrosion.



2 COUNTERFLOW heating and deaerating, a feature of all Swartwout feed water heaters, assures efficient removal of contaminating gases. Just before dropping into storage section, feed water is in contact only with clean steam, thereby preventing reabsorption of oxygen. Through counterflow, last traces of oxygen are removed from feed water according to law of partial pressures of gases.



3 VENT CONDENSER is smaller in heaters utilizing counterflow principle. Because less steam does more work, a large condenser is totally unnecessary — important from the standpoint of maintenance economy. Swartwout makes a complete line of deaerating and open heaters — from 5,000 to 300,000 lbs. capacities.

A-2675

Swartwout

POWER PLANT EQUIPMENT

SEND FOR BULLETIN S-18-E • THE SWARTWOUT COMPANY, 18511 EUCLID AVENUE, CLEVELAND 12, OHIO

Learn the Answers—Ahead of Time

The future looks good for power engineers. I said that last month, and I'll say it again. Thirty years from now our country's production and our standard of living will be much higher than we may even dream possible. That's what the experts are constantly telling us.

Now I'm no expert, but I know this: If America produces more goods, the amount of power generated and consumed every day must go up too. More power means more responsibility for us, the power engineers. My only question is: Are we "ready" for it?

Sure, if someone were to hand us a brand-new silver-plated plant and tell us to run it, most of us could step in and do it. But that's not what I mean by "ready."

Suppose your plant is part of a manufacturing concern that's doing more and more business every year. That means more and more power load. Some day the power plant will be too small for the load. What then? Will you wait for the factory manager to complain that he doesn't have enough steam or electricity before you do something about your power shortage?

Or will you have tipped off the brass hats ahead of time? And as the man best qualified to talk about your own plant, will you have a plan of your own ready—a plan showing the best way to boost capacity as the business grows?

Suppose, for instance, you're chief engineer in an office-building plant, or a department store, hotel or hospital, and you notice how uncomfortable everyone is in the summer time. Then the management calls you in to discuss air-conditioning the building. Will you have some sort of tentative plan ready? Will you know answers to questions like: Is cooling water available? Can the plant take the additional load? Can the roof hold a cooling tower? and many other questions to be answered before seriously considering air conditioning? Or will management have to turn outside your department for initial help because you haven't kept yourself well informed?

The future looks good for power engineers—if they take advantage of it. That means each one of us must think seriously about the future needs of our plants. We must learn the answers ahead of time, or take a back seat as someone else picks up the reins.

George Edwards

Engineer

Power plant of Republic Aviation Corporation, Farmingdale, N. Y. Texaco Ursa Oil has lubricated one of these 300-h.p. Chicago Pneumatic Diesels for eight years, and the other for seven years.

"...ALL RINGS FREE" after 10,000 hours lubricated with TEXACO URSA OIL

When Republic Aviation Corporation's Diesels were overhauled after 10,000 hours of operation with *Texaco Ursa Oil*, Mr. Bob De Fau, Chief Stationary Engineer, reported as follows:

> "All rings were found to be free, and cylinder walls showed a minimum amount of wear. Engines have since been in operation for more than 6,000 hours and at present use about 1 gallon of make-up oil to each 19 hours of running. Same oil is also used for lubrication of valve stems."

Texaco Ursa Oils are especially made for Diesel lubrication. Their high resistance to oxidation, heat and pressure means clean operation . . . freedom from power-killing carbon, sludge and varnish . . . lower maintenance costs . . . reduced fuel consumption.

That is why leading Diesel engine builders approve *Texaco Ursa Oils*, and why ***more stationary Diesel h.p. in the U. S. is lubricated with Texaco Ursa Oils than with any other brand.***

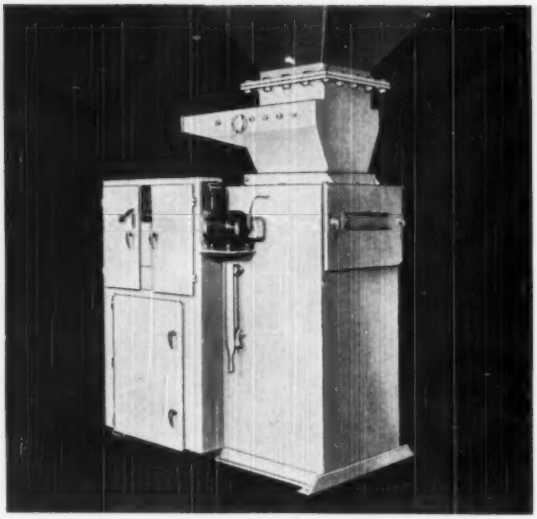
Get top performance from your Diesels. A Texaco Lubrication Engineer will gladly help you. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, New York.

TEXACO

TEXACO Ursa Oils

FOR ALL DIESEL ENGINES

TUNE IN . . . TEXACO presents MILTON BERLE on television every Tuesday night. METROPOLITAN OPERA radio broadcasts every Saturday afternoon.

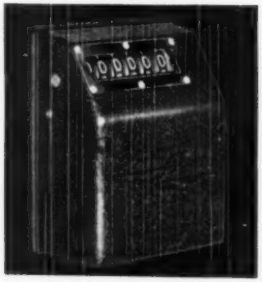


ELECTRIC COUNTER OF S-E-CO.

COAL SCALES ASSURES ACCURACY

Electrical operation of counters on S-E-Co. Coal Scales means that there are no mechanical connections required between the counter and any part of the weighing system. Therefore, there can be no errors in weights due to improper adjustment of a mechanical linkage. Counter may be located on scale or where desired.

Why not use S-E-Co. Coal Scales in your plant and obtain accurate coal weights with the electric counters.



Write for bulletin.

STOCK ENGINEERING COMPANY

715P Hanna Building ★ Cleveland 15, Ohio

ELECTRONICS

(*Continued from page* 124)

large section. On the other hand, for surface case hardening the frequency may be as high as 1,000,000 cycles per sec. Frequencies used in dielectric heating range from 2,000,000 to 100,000,000 cycles per sec. Most dielectric heating is done at frequencies between 10,000,000 and 30,000,000 cycles per second.

Oscillator Operates Relays. Fig. 8 diagrams an oscillating circuit used to operate a relay. In this circuit arrangement the grid circuit is tuned (oscillates). Having the grid circuit tuned, as is usual for relay operation, has the same effect as when the anode circuit is tuned for induction and dielectric heating, Fig. 1 to 5.

In Fig. 8 the relay coil, being wound on an iron core, has very high inductance, and practically blocks the flow of high-frequency current through it. Coils L and L_1 have comparatively low inductance, being wound without an iron core. They are spirally wound in flat disks so their faces can be placed near each other.

For elevator control service the inside faces of the two disk coils are about 1 in. apart. In meters and other devices the coils are small, and may be only a small fraction of an inch apart. They are placed this way to get a good inductive couple between them. Then a change in coil L current will induce a voltage in coil L_1, the same as the primary winding of a transformer induces a voltage in the secondary.

Normally the grid circuit oscillates at about 200,000 cycles per sec, and current flows through the tube for a short part of each cycle. Since the anode current changes so rapidly, inductance of L and the relay coil keeps the average flow to only a small part of that required to actuate the relay. The relay, therefore, remains inactive.

When the coupling between coils L and L_1 is broken, as can be done by a metal plate between them, Fig. 9, grid circuit oscillations stop. The grid bias drains off through resistor R and the tube passes a steady direct current, which readily passes through L and the relay coil. This current actuates the relay.

Relay-Circuit Operation. To study circuit operations, Fig. 8 and 9, let us first consider only the anode part of the hookup, Fig. 10. Assume the grid has a minus bias to block the tube. Under this condition capacitor C_2 gradually becomes charged to the polarity shown. This circuit is from — line, C_2, coil RE, and to + line. When the capacitor is charged to line voltage, current ceases to flow.

Now assume the grid bias is suddenly removed or made plus. The tube con-

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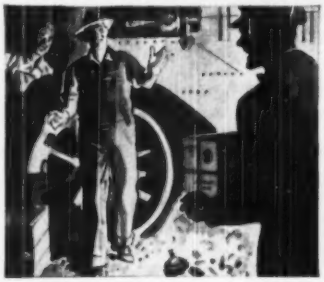

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ducts and current through coil RE increases to a normal value to close the relay, Fig. 11. While this was happening, voltage across the capacitor dropped to a value equal to line volts, less that across the relay coil. We can assume this to be one-half line volts.

Capacitor C_2 is, therefore, charged to too high a voltage and it discharges through the tube and L. When its charge corresponds to one-half line volts, it ceases to discharge. This occurs simultaneously with the increase of current flow through coil RE.

If we were again to make the grid minus, Fig. 10, the tube would be blocked and capacitor C_2 charged to full line volts. Returning to the conditions in Fig. 11, the tube would again conduct and C_2 give up part of its charge. If grid polarity were to change rapidly, because of the inductance of coils L and RE, the tube could pass only short-current impulses that could not close the relay.

The grid's oscillating circuit in Fig. 8 changes the grid's polarity about 200,000 times per sec. The tube passes this number of current impulses; each impulse lasts for only a small part of each cycle of the oscillating circuit. Each current impulse through the tube and coil L induces a voltage in coil L_1. In this way power is fed into the grid circuit to keep it oscillating and to hold the relay open.

Metal-plate Closes Relay. When a metal plate is placed between the coils, Fig. 9, eddy currents are induced in it. This plate acts as a short-circuited secondary in a transformer to break the couple between L and L_1. A voltage is no longer induced in coil L_1 and oscillations cease. As the charge in capacitor C_1 drains off, grid bias drops to zero and the tube conducts a steady dc current. This current flows through coil RE and closes the relay.

The relay remains closed until the plate moves out from between the coils to reestablish the couple between them. Again oscillations start in the grid circuit and the relay opens. When the grid circuit is oscillating, only about 1 milliampere passes through the relay coil, compared to about 15 when oscillations cease.

On elevators the metal plates that pass between the coils are mounted on the hoistway wall or guide rails. Coils L and L_1, the tube along with the capacitors, are assembled as a unit and mounted on top of the car. Several of the units may be required for slowing down and stopping the car. They are so installed that, as the car moves up and down the hoistway, the stationary metal plates pass freely between the coils. As the car approaches a floor, the slowdown relays are first actuated, and finally the stopping relay stops the car and

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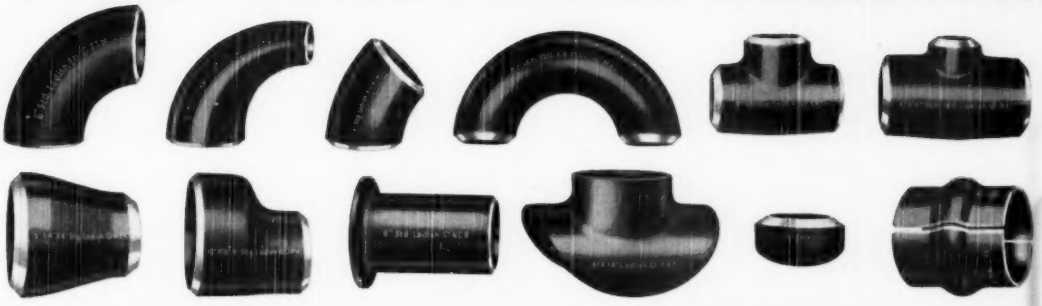

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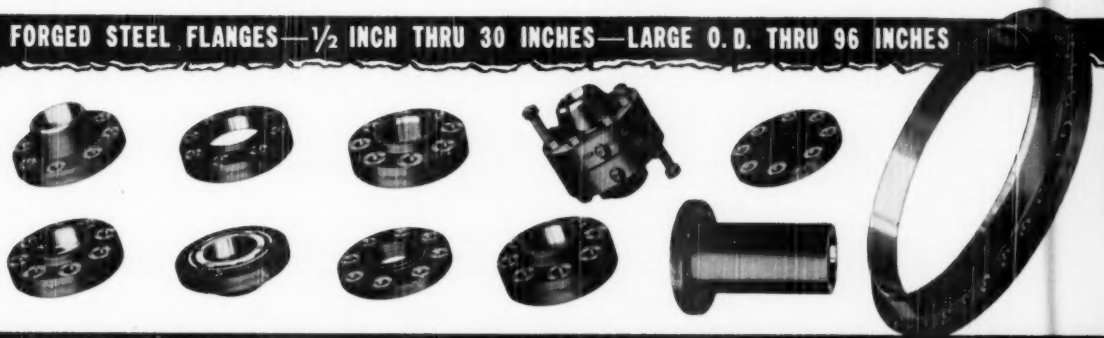

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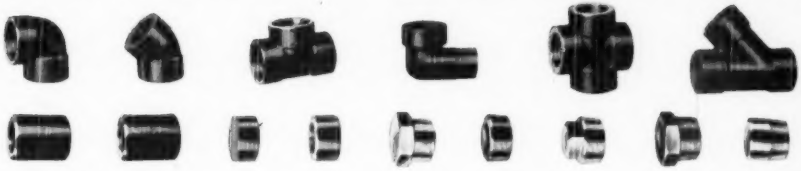

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Oil in steam condensate reduced to less than .25 p.p.m. with the new . . .

SPARKLER PROCESS

For the first time oil can now be easily and cheaply removed from return steam condensate down to the remarkably low point of .25 p.p.m.; under favorable conditions even as low as .1 p.p.m., and without loss of heat or water softening values.

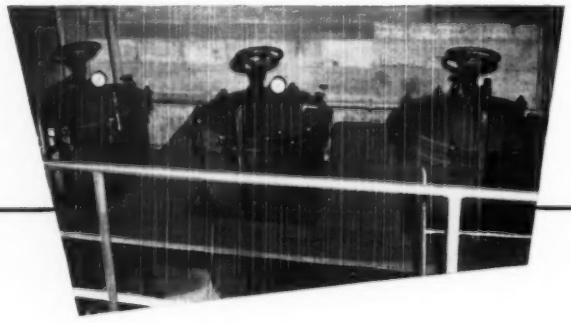
The average skimming or trapping method of oil removal leaves 12 to 20 p.p.m. of emulsified oil in the water. The better oil adsorbent methods now widely used succeed in getting the residual oil down to 3 to 5 p.p.m.

The new Sparkler process, a much improved method based on the oil adsorbent principle, reduces the residual oil to the remarkably low point of .25 p.p.m. with capacity for any required flow rate, and without loss of heat or water softening values.

The engineering details of this new process will be very interesting to any power plant operator who is having difficulty with oil removal from return steam condensate.

Write Mr. K. L. Carr, Sparkler Mfg. Co., Mundelein, Ill. Give details of your problem. Our engineers will personally supervise the installation of this new process in your plant to insure efficient and satisfactory operation.

Filters used in one installation of this process that provide a flow rate of 200 gallons per minute.



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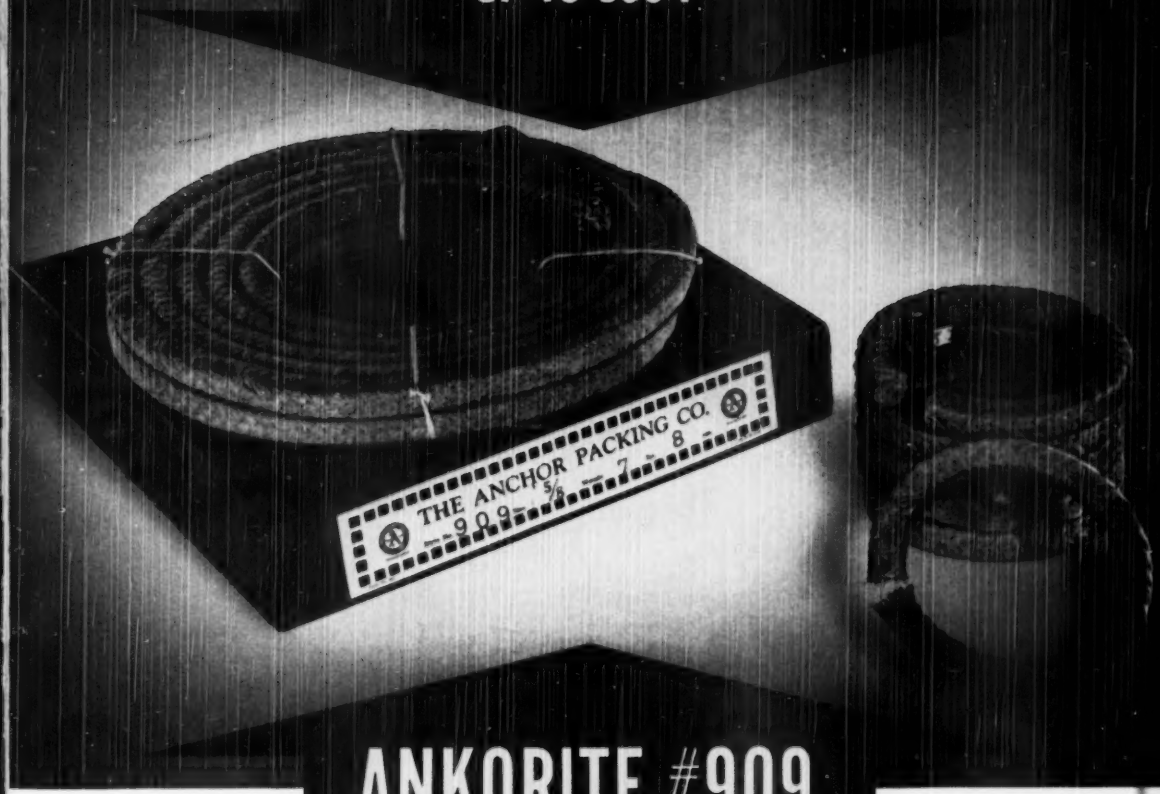

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Ankorite No. 909 is a square braided asbestos packing, soft and pliable, suitable for any packing purpose on temperatures up to 500° F.

Contains no graphite and is lubricated with a high temperature white lubricant, adaptable to any food handling apparatus.

Also ideal for packing against gasoline and other hydrocarbon solvents, and on stainless steel parts.

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STRONG* Traps

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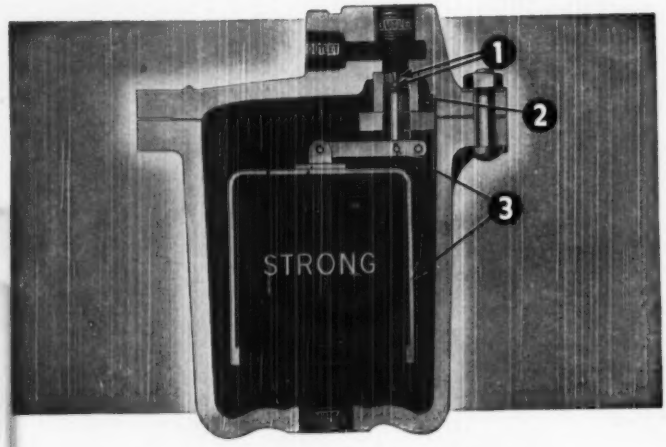

Look for these three STRONG low-maintenance features in the STRONG 80 Series Inverted Bucket Trap:

1. **Anum-Metl Valve and Seat—guaranteed leakproof for one year;**
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Compare these features with other traps!

STRONG 80 Series Trap sizes ½" to 2½", pressures to 250 lbs., temperature to 500° F. (forged steel for higher pressures).

Dual outlet simplifies piping, bottom inlet keeps trap cleaner. Years of trouble-free operation assured by super-STRONG construction.

Catalog No. 68 describes inverted, open bucket and other types of STRONG traps. Write today.

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STRONG, CARLISLE & HAMMOND COMPANY

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then levels it automatically at the floor.

Oscillator in a Meter. The oscillating circuit may be placed in a meter, for example, in a temperature indicator. Coils L and L_1 are mounted on an adjustable arm and set at the temperature in an electric furnace. The indicator's pointer carries an aluminum foil vane.

As the pointer swings to the desired temperature, the vane moves in between the coils. This stops the oscillations in the grid circuit to actuate a relay and reduce power input to the furnace. When the vane moves away from the coils, oscillations again start, and power is increased to the furnace. In this way the temperature is maintained practically constant.

Here we have studied some high-frequency oscillating circuits and how they operate. There are many others but those we have considered give a general idea of their possibilities. For those who would care to delve into this subject further the following books are recommended. *Electronics in Industry*, by George M Chute, McGraw-Hill Book Co, New York; *Electronics for Industry*, by W I Bendz, John Wiley & Sons, New York; *Elementary Industrial Electronics*, D Van Nostrand Co, New York; *Electronics for Electricians and Radio Men*, Coyne Electrical School, Chicago.

WOOD FIRING

(*Continued from page* 117)

an even fuel bed. We discarded the steel rails after a few months' operation and replaced them with cast-iron bars at the same angle and spacing. The steel sagged and buckled.

Charcoal Firing. Charcoal falls through the grate into the water seal and is quenched. Initially, amount of moisture absorbed by charcoal ran 40 to 50%. With this high moisture content, attempts to mix it with coal fed to the pulverizers proved unsuccessful. Only a small part of the daily output could be used in the direct-fired refinery boilers. Since about 15 tons were produced daily, there was a steady accumulation of charcoal.

Finally we found that by altering the quenching arrangements to give a minimum water spray, moisture content of the charcoal could be held to 20-25%. This was low enough to enable it to pass the pulverizers satisfactorily. It is interesting to note that, when grinding charcoal, wear on the pulverizer is about twice as rapid as with coal.

Limited grate area kept output of these 40,000-lb-per-hr boilers to about 22-24,000 lb on wood firing. Using the charcoal, however, increased output by about 10-12,000 lb. Temporary fuel pipes for charcoal were fitted between waterwall tubes. The fishtail opening

WORLD'S FIRST MERCURY UNIT POWER PLANT*

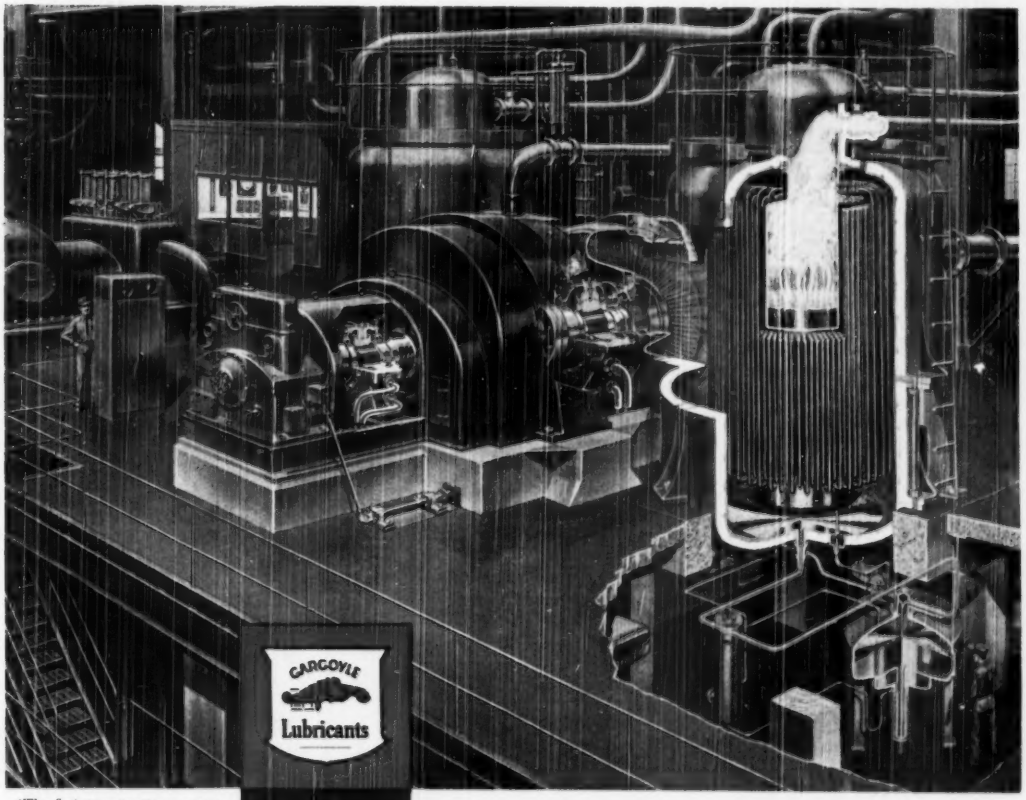
...gets the World's Greatest Lubrication Knowledge and Engineering Service

THIS unique mercury-steam turbine combination was built by General Electric for the Public Service Company of New Hampshire.

The new plant -- now in operation in Portsmouth -- teams two 7,500-kw mercury turbines (one cut open, center) with a single 25,000-kw steam turbine (left). Mercury vapor, which runs the smaller turbines, generates steam when it is condensed for re-use. This steam, in turn, is superheated and used to power the larger turbine. There are no fuel-fired steam boilers.

This first mercury unit power plant -- like so many other "firsts" in industry -- is lubricated 100% by Socony-Vacuum. Famous Gargoyle D.T.E. Oil 797 helps protect costly bearings and other parts. Other Gargoyle Oils help keep auxiliary equipment on the job.

Why not get the world's greatest lubrication knowledge for *your* plant, too?



GARGOYLE Lubricants

*The first mercury-steam power plant designed and co-ordinated as a unit station.

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Correct Lubrication

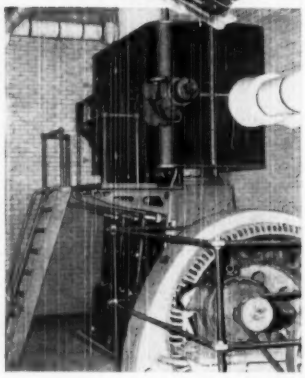
MAKERS OF FAMOUS

HOLGATE TOYS

GENERATE THEIR OWN POWER WITH A

SKINNER "UNIVERSAL UNAFLOW" STEAM ENGINE

Engine room view of 800-kw, A-C Skinner Vertical "Universal Unaflow" Steam Engine at Holgate Brothers Company.



"Old as the Nation." In 1789, the year which saw George Washington take office as first President of the United States—Holgate Brothers Company, Kane, Pennsylvania, was established. Through its entire history, Holgate has devoted its production to and has been a leader in the woodworking field. This 161 year old manufacturer is today best known for Holgate Toys—famous among child educators, parents and children.

An 800-kw. Skinner vertical "Universal Unaflow" steam engine-generator unit has been recently installed in the Holgate plant to supply electric power, with exhaust steam being used for heating and processing. Still in daily operation are two Skinner steam engines, one installed more than 20 years ago. The installation of the new engine is testimony that "a repeat order is the best evidence of satisfaction."

Investigate the Skinner way of generating electric power, or of driving compressors, blowers, refrigeration and air conditioning equipment in your plant, hotel or institution. Catalogs and detailed information are available on request.

For Over 80 Years, Doing One Thing Well—Building Steam Engines

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was about six feet from the grate.

Slag Formation. One of our greatest difficulties was formation of an alkali calcium-silicate slag from the wood ash. This rapidly covered the whole grate area, requiring boiler shutdown. Continuous air lancing, supplementing forced draft under the grate, overcame it. We observed that, with wood firing on the chain grates of the refinery boilers, this slag formation was small. Grate movement easily eliminated it.

Third Conversion. A third boiler was later put on wood firing by feeding wood to a grate of steel rails with a slope of 60 deg. This was at the flue end of No. 4 reverberatory, which was on spare service during the reduced production enforced by the coal shortage. Our calculations indicated that, with continuous firing, the grate area would produce 50-60,000 lb per hr. Under steaming conditions, output actually averaged 40-50,000.

We built a ramp to winch cars to a platform above the reverberatory's rear end, about 10 ft above the grate. An entire carload was tipped at once through steel doors raised on counterweights during charging. This furnace was intended to be of even more temporary nature than the others. It was quickly and cheaply constructed by utilizing three walls at one end of the reverberatory and erecting a front wall of magnesite brick within it.

Nchanga Experience. At the Nchanga power plant, steam is generated by four International Combustion boilers rated 40,000 lb per hr at 360 psi and 750 F. We built a dutch oven to carry heat and gas from the burning wood to the combustion chamber of one of these boilers. In this way we hoped to overcome the slag and charcoal problems first experienced at Rhokana.

Wood in 4-ft lengths was brought by cars to a platform above the oven. It was thrown by hand onto a grate sloping toward the exit end of the oven. Preheated forced-draft air at about 450 F came in under the grate in four separate compartments. We found that output had to be limited to 20,000 lb

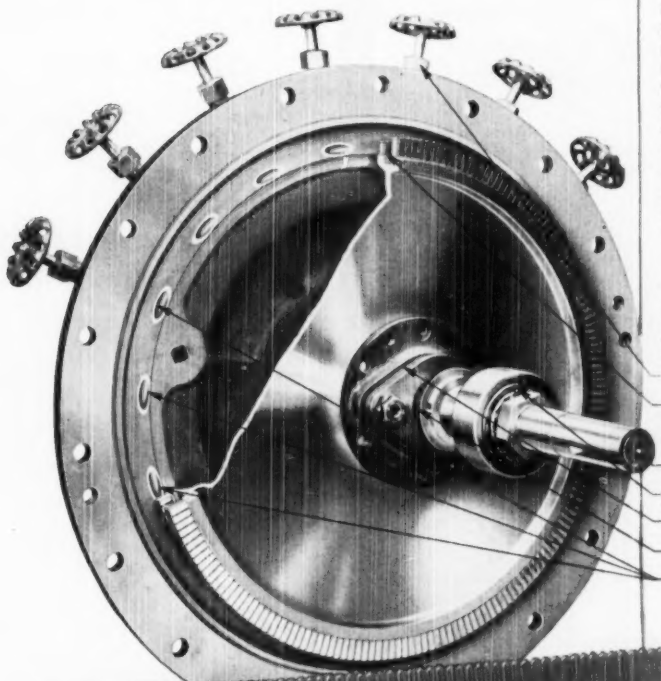
WOOD-ASH ANALYSIS

Silica, SiO_2	33.70%
Alumina, Al_2O_3	2.21%
Lime, CaO	24.30%
Magnesia, MgO	7.30%
Iron, Fe_2O_3	4.22%
Phosphorus, P_2O_5	5.44%
Titania, TiO_2	0.01%
Manganese, Mn_3O_4	0.54%
Copper, CuO	0.87%
Sulphur, SO_3	2.90%
Soda, Na_2O	5.40%
Potash, K_2O	8.87%
Nitrogen, N	0.03%

No other steam turbine offers you

SUCH VERSATILE STEAM NOZZLE CONTROL

The larger number of hand valves you see on a Coppus Steam Turbine promises you greater operating economy. At least 60% of the steam nozzles can be individually controlled to give maximum steam pressure in steam chest . . . a guarantee of best water rates at any load. Maintenance economy, too, is assured by the hard chromium plating of the shaft at the stuffing box. It provides the best possible smooth, non-corrosive surface for packing rings.



- 7 hand valves for efficient partial load operation, (20" turbine shown)
- 2 row velocity-stage turbine wheel with stainless steel turbine buckets — statically and dynamically balanced
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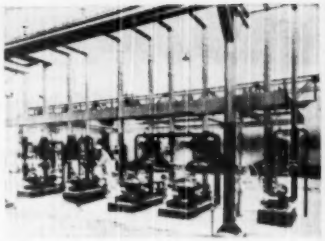
- Heavy chrome plating of shaft through stuffing box
- 3 nozzles always open



Coppus Steam Turbines, Type TF, driving chemical transfer pumps at Celanese Corporation of America's Chemcel Plant

Coppus Steam Turbines ranging from 150 hp down to fractional in 6 frame sizes

MAKE TURBINE DOLLARS GO FARTHER

Why waste money buying turbines with higher horsepower ratings than you need? The higher the horsepower rating, the higher the price. Save money by selecting the Coppus Turbine size closest to your requirements from 150 hp down to fractional. And when you do, you save operating and maintenance costs, too. That's what these other Coppus features are designed to do: exclusive pilot operated excess speed safety trip supplementing constant speed governor; choice of metallic or carbon ring packing assemblies. Designs available for back pressures up to 75 pounds; replaceable cartridge type bearing housings. For full details . . .

WRITE FOR BULLETIN 135

COPPUS ENGINEERING CORP., 162 Park Avenue, Worcester 2, Mass. Sales offices in THOMAS' REGISTER.

COPPUS "BLUE RIBBON" TURBINES

For GREATEST
DEPENDABILITY and EFFICIENCY
in metered pressure pumping of
SULPHURIC ACID
...at all concentrations

Here is the equipment which will handle sulphuric acid, in all concentrations, performing the dual function of taking the acid from atmosphere pressure to line pressure, and metering or proportioning its flow. Because the Pulsafeeder has no stuffing box—but uses instead an hydraulically-balanced diaphragm seal, it eliminates leakage, prevents corrosion of pump or contamination of product, avoids loss of prime—all at lowest possible maintenance. Hundreds of satisfactory installations to back up these claims!

- NO STUFFING BOX OR RUNNING SEAL
- HYDRAULICALLY-BALANCED DIAPHRAGM SEAL
- POSITIVE DISPLACEMENT PISTON MEASUREMENT
- FLOW RATE ADJUSTABLE WHILE IN OPERATION
- OIL-BATH LUBRICATION OF ALL MOVING PARTS
- UNITS AVAILABLE FOR MANUAL OR AUTOMATIC CONTROL

Lapp
PULSAFEEDER
PISTON-DIAPHRAGM CHEMICAL PROPORTIONING PUMP

WRITE for Bulletin 262 with complete description and specifications.
LAPP INSULATOR CO., INC., PROCESS EQUIPMENT DIVISION, 273 MAPLE STREET, LE ROY, N. Y.

per hr, since at ratings of 25-30,000 the fireclay refractory failed.

A second boiler was later converted by erection of a dutch oven lined with magnesite brick. Design was modified to give greater hearth area and to shorten the distance flue gas had to travel to reach the boiler tubes. In the suspended-arch roof we used brucite bricks. These alterations resulted in much better performance and this unit operated satisfactorily at 30,000 lb per hr. A higher rate would undoubtedly have been obtained if wood could have been fed faster to the furnace. Actually, output was limited by labor, transport and haulage difficulties around the front of the oven.

Conclusions. Handling difficulties of wood firing, as well as the large amount of labor needed, makes it uneconomical except in emergencies. By supplementing meager coal shipments, however, it tided us over a bad period and kept the copper-mining industry from greatly reduced production or actual shutdown.

TECHNICAL BRIEFS

(*Continued from page* 138)

The paper carries tables on operating and investment costs, as well as a diagram of the coal-handling layout. *ASME paper No. 49-A-98.*

BEARINGS AND DRIVES

BALL- AND ROLLER-BEARING IDENTIFICATION STANDARDS AND DESIGN SELECTION, *by Aaron Hochman, Cataloging Officer, U. S. Navy.* Few industrial products have become more indispensable, and undergone more rapid, wider specialization than ball and roller bearings. These primary machine elements, produced in special factories in many countries, enter into the construction of virtually every kind of mechanism with rotating parts used by the industries of the world. Their properties have frequently contributed greatly to technical and economic progress in different branches of engineering.

Conditions that influence the selection of a bearing type or size are varied and complex. Naturally the needs of the specific application control such factors to a high degree. Magnitude and type of external forces and stresses, speed of rotation, operating temperature, peculiarities of shaft mounting and housing fit, life and safety factor are all primary limitations in selecting the most appropriate bearing type and size. There is, however, one additional consideration to keep in mind.

Service engineering is predicated upon the principle of high quality, low price, and availability of products. These desirable characteristics can be

TIMKEN® bearings help provide high availability for stoker operation

THIS Detroit RotoGrate Stoker is designed to burn up to 12 tons of coal and to produce over 200,000 pounds of steam per hour. It is a heavy duty spreader type—a second repeat order since 1940—just installed to provide additional dependable steaming capacity for a prominent automobile builder.

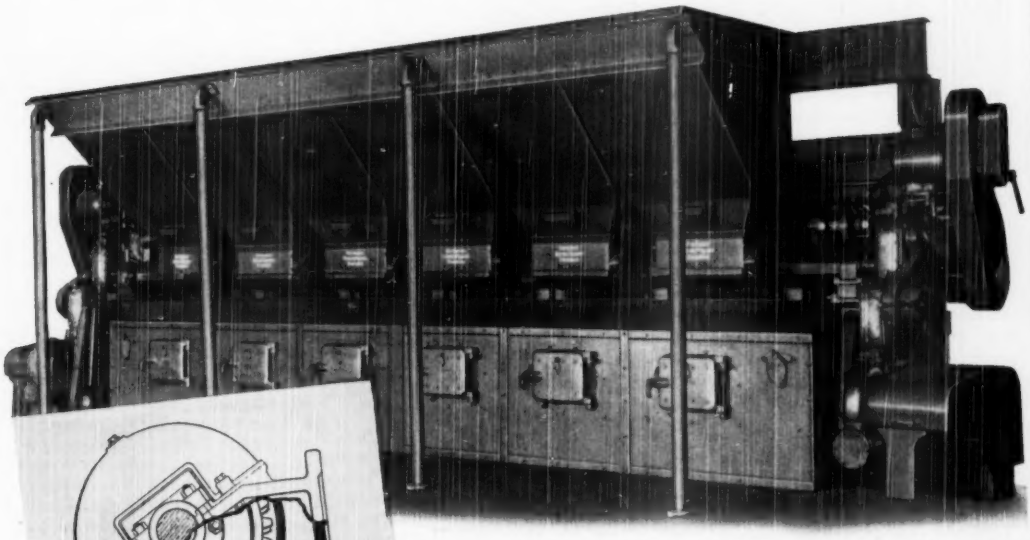
Timken® bearings were selected to support the gearing that moves the massive grate slowly and continuously forward with minimum power consumption.

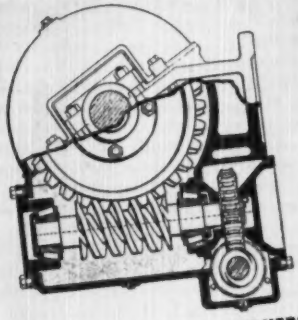
Due to their tapered design, Timken bearings carry any combination of radial and thrust loads without deflection or end-play. Gears are held in proper alignment, preventing excessive wear and breakdown. Because of the line contact between rolls and races, Timken bearings have tremendous load-carrying capacity. And since they're made of the best steel ever developed for tapered roller bearings—Timken fine alloy steel—Timken bearings normally last the life of the machine in which they are used.

The true rolling motion and incredibly smooth surface finish of Timken bearings insure minimum friction. Lubricants are retained, dust and dirt kept out, because Timken bearings permit the use of close-fitting closures.

Backed by 50 years of bearing research and development, Timken tapered roller bearings are first choice throughout all industry. No other bearing can bring you *all* the advantages you get with Timken bearings. Look for the trade-mark "Timken" on every bearing you use. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.





DETROIT ROTOGRATE STOKERS *get continuous, trouble-free grate movement with minimum power with Timken bearings in drive mechanism.*

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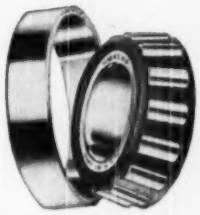
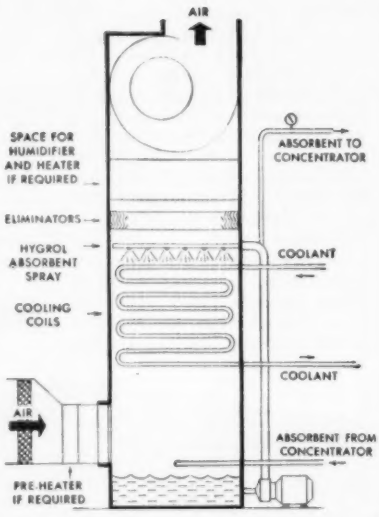
TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▱ BEARING TAKES RADIAL ◐ AND THRUST ↔ LOADS OR ANY COMBINATION ✳

New Method Gives Precise Control in Air Conditioning

Niagara "Controlled Humidity Method" Uses Hygrol, Hygienic Liquid Absorbent

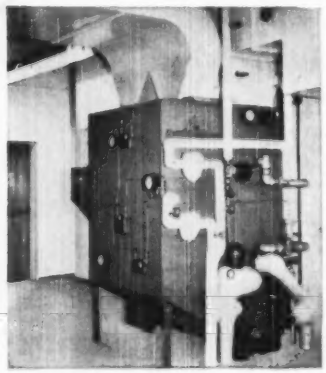


NIAGARA CONTROLLED HUMIDITY METHOD — FLOW DIAGRAM

● The Niagara "Controlled Humidity Method" is a new system of air conditioning giving complete control of temperature and relative humidity, holding constant conditions or varying them at the will of the user. Especially, it provides dry air at normal atmospheric temperatures with little or no refrigeration required. A condition of 15 grains of moisture per pound of air at 85 deg. F. dry bulb temperature has been produced without refrigeration.

The apparatus is enclosed in a casing thru which the air is drawn by fans. The air is filtered and then enters a chamber where it is dehumidified in passing thru a spray of "Hygrol" Liquid (a hygienic hygroscopic chemical that absorbs the air-borne moisture and contains no salts or solids to precipitate) In the same chamber are located cooling coils which remove the latent heat of evaporation and also sensible heat as required.

The absorbent liquid spray falls into a tank at the base, where it is piped to a concentrator, removing moisture taken from the air. The re-concentrated liquid returns to the system. This process is continuous, and the apparatus operates at full capacity at all times.



The same equipment may be used to provide winter air conditioning when required, by installing a tempering coil at the outdoor intake, an humidifier, and a reheat coil above the eliminators.

This equipment is manufactured in a range of sizes providing from 1000 to 20,000 CFM of conditioned air from a single unit, and mutiple unit installations are practical. It is expected that, by reducing the need for refrigeration, the cost of air conditioning will be reduced by this method. Applications generally are in a temperature range from 35 deg. F. upward. Below the freezing temperature of water. the Niagara "No-Frost" method is applicable.

The equipment is protected by U. S. and foreign patents. Installations have been made in food and chemical process industries, in packaging hygroscopic products, for preventing condensation of moisture on metals and other products in storage, in air conditioning for laboratory control and for human comfort.

For further information, write Niagara Blower Company, Dept. **P**, 405 Lexington Ave., New York 17, N. Y.

(advertisement)

combined only if the products are manufactured on a large scale. Such manufacture is possible only if user and manufacturer agree on a limited number of constructions and sizes.

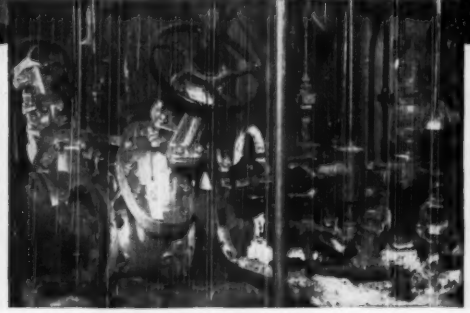
A bearing that has given due service may have to be replaced by another, which must be so exactly like it in dimensions and characteristics as to preclude all difficulty either during or after fitting. So farseeing engineers expect and insist that bearings shall be produced in standard constructions within range of agreed dimensions.

This paper presents a brief outline of the background of development of existing identification standards for ball and roller bearings, including a limited explanation of the content of the joint Army-Navy-Air Force Standard currently in use within the National Military Establishment. It also includes brief analyses of the common bearing types and a discussion of more important considerations in the selection of a bearing for a particular design application. *ASME Paper No. 49-A-44.*

THE POWER CAPACITY OF A ROLLER-CHAIN DRIVE CONSIDERING WEAR AND VIBRATION, *by R C Binder, professor of mechanical engineering, Purdue University.* Power capacity or rating of a roller-chain drive is an important feature to user, designer and manufacturer of the drive. Numerous factors have to be considered in power ratings. For example, one service requirement of a drive may be a limit on chain-wear elongation in a given time. For an exceptionally severe application a limit may be placed on chain breakage and abuse. Another limit may be placed on the noise of the drive, and still another on the over-all dimensions of the drive. Thus it may be necessary to consider various separate factors and to select one drive that satisfies all limits.

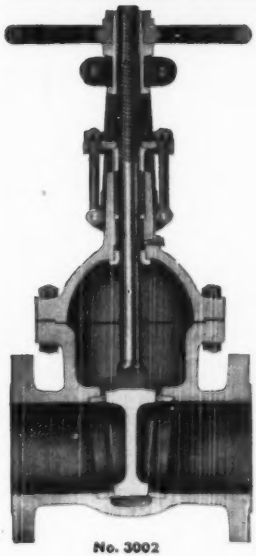
A review of the numerous factors indicates that two main ones are wear and vibration. Others can be correlated in these two, and the analytical break point should include these two, at least in major roles. The author presents an analytical study of a simple type of roller-chain drive considering wear and vibration. The operating range of the drive is divided into two regions, for which power-speed relations are given. In one, the impressed tooth-contact frequency is equal to or less than the highest natural frequency of the strand vibration. In this region vibration characteristics may be correlated with roller impact and such possible consequences as roller breakage, noise heating and wear of sprocket teeth. In the other, the impressed frequency is above the highest natural frequency of strand vibration, and the major factor is chain wear and elongation. *ASME Paper No. 49-A-101.*

OHIO EDISON CO. is one of the many light and power companies throughout the nation that use OIC Valves. Pictured is the Ohio Edison Gorge Power Plant that supplies a portion of the electricity requirements of the Greater Akron area.



OIC

SETS THE PACE IN VALVES



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OIC Valves are the answer to the demands of light and power companies for valves that function with absolute precision and safety for long periods of time. There are good reasons — dozens of pace-setting features that show why OIC Valves are steadily gaining nation-wide preference.

There are no flow obstructions to cause turbulence and pressure drop in OIC Valves. OIC Valves have streamlined, straight-through ports with inner walls as smooth as glass! The heavy I-beam wedge rises entirely clear of the fluid passageway. There are no recesses or pockets between the valve body ports and the seat openings. And OIC Valves are built with rugged strength to withstand the highest pressures. OIC Valves give you extra body-wall thickness . . . precisely calculated flange and gasket dimensions . . . accurate distribution of materials to prevent concentration of stresses in any one part.

OIC Valves save you money by helping you avoid extra pumping. You get *steady* pressure you can depend on! You handle your flow requirements more efficiently — more economically!

Eliminate Change-Over Difficulties with the Handy OIC Cross Reference Chart Just check the number of the valve that you wish to replace, look in the OIC Cross Reference Chart, and you will find the number of the OIC Valve to replace it. For your free copy, write to *The Ohio Injector Company, Wadsworth, O.*

OIC VALVES

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Gives you the

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You won't believe any tube cleaner can pack such tremendous power, until you try the new ROTOJET. It removes scale so much faster that it usually pays for itself in one cleaning. Models available for practically any size straight and curved tubes. Send for ROTOJET Bulletin.

THE SECRET

ROTOJET Motor has only two moving parts, a shaft and a paddle. Positive contact between paddle and Rotocentric (egg-shape) bore cylinder prevents stalling at low speeds. No leakage. Delivers maximum power for air used.

S-530 ROTOJET Air-driven Motor with swing-frame head for 3¼–3-13/16" I.D. straight tubes.

ELLIOTT COMPANY-ROTO DIVISION

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SILICA REMOVAL

(*Continued from page* 95)

were calculated using these four methods on three types of water analyzed in Table II. Calculations were based on 66 deg Baume sulphuric acid costing 1¢ a lb and 100% sodium hydroxide at 3¢ a lb.

Results are summarized in Table I. Examination of the table indicates that each water supply presents a specific design problem. Careful consideration of all the factors can bring about an appreciable reduction in operating costs.

The last column of Table I relates to a further operational refinement, which affords an additional reduction in chemical costs with those systems employing a highly-basic anion unit in series with a weakly-base anion step. Since the caustic with which the former is regenerated is only partly spent on passage through this resin, the waste regenerant can be used for rejuvenation of the latter unit before discharging the solution to the sewer. With the water types illustrated, sufficient unused NaOH is available for complete regeneration of the weakly-basic anion exchanger, and the total treatment costs can be decreased accordingly.

Water-conditioning engineers have been quick to recognize the potentialities of this low-cost method for producing water of the highest quality. Already sizable installations have been made, others are being constructed and the trend is accelerating rapidly toward deionization plus silica removal—the ultimate in feedwater conditioning.

BOOKSHELF

(*Continued from page* 154)

dustrial Press, 148 Lafayette St, New York 13, N. Y.

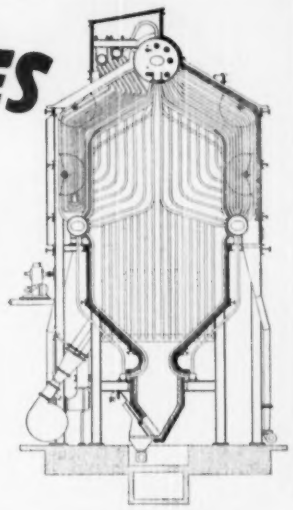
Proper selection of pipe joints, based on intelligent consideration of all factors, is of vital interest to power engineers. This book brings together in handy form the factors that bear on the problem. Moreover, it applies them to piping materials on the market, metallic and non-metallic.

The ten chapters are: Screwed joints for ferrous and brass pipes; Flanged pipe joints; Welded and brazed pipe joints; Methods of joining cast iron; Joints for thin-wall tubes; Joints for plumbing and chemical-resistant pipe; Joints for vitreous tile and concrete pipe; Joints for transite pipe; Joints for wood pipe; Joints to permit movement.

REVIEW OF CURRENT RESEARCH AND DIRECTORY OF MEMBER INSTITUTIONS (1949). 186 *pp, paperbound.* $1.75 *postpaid from Engineering College Research Council, c/o F M Dawson, chairman, College of Engineering, State University of Iowa, Iowa City, Iowa.*

Over 4000 college and university research projects in engineering subjects,

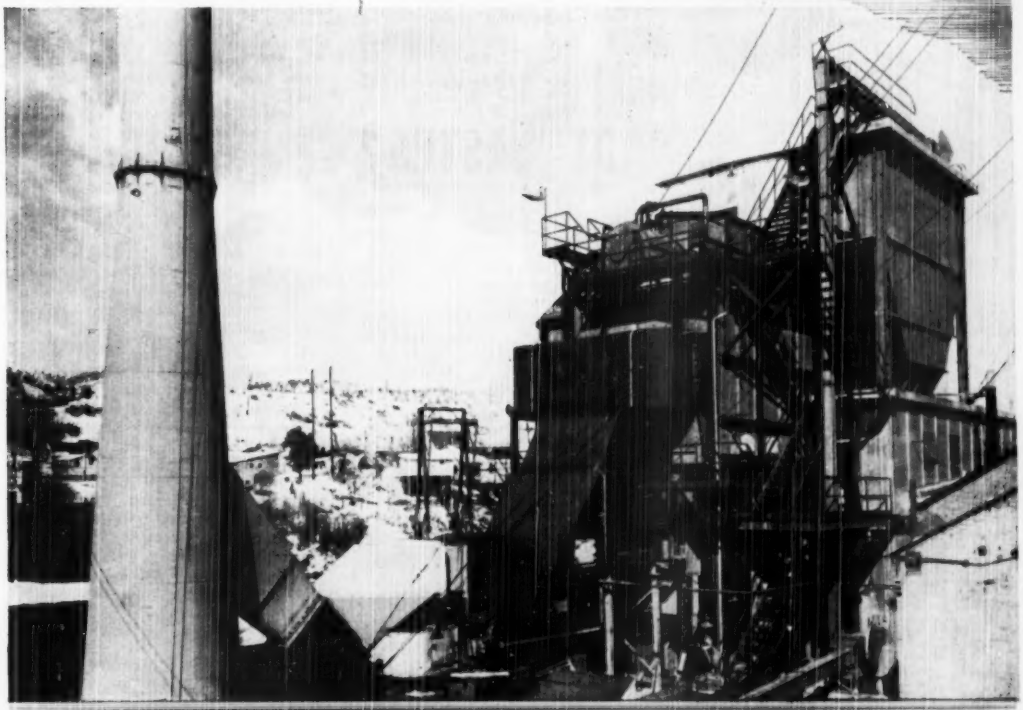
UNION OUTDOOR STEAM GENERATING PLANT *in the* ROCKIES



This Union "H" Type steam generator requires no costly building to house it. The steel cased boiler with superheater, dust collector, air heater, ducts, fans and stacks are out-of-doors, at 6500 feet elevation.

It is designed for 60,000 pounds of steam per hour at 450 psig and 750 Deg. F., fired with pulverized coal, oil and gas combination fuel burning equipment.

The superheater is located on one side only, providing constant superheat over a wide load range by automatic adjustment of the boiler outlet dampers controlling the gas flow across the superheater.



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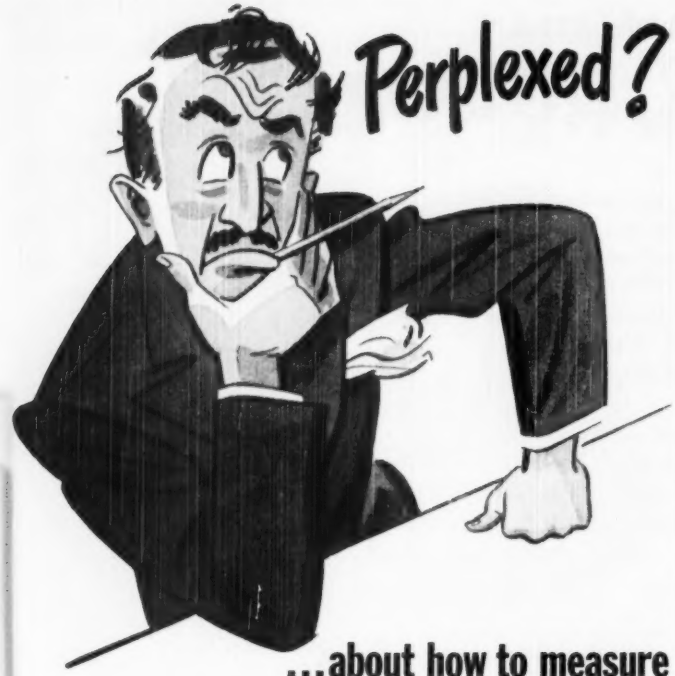


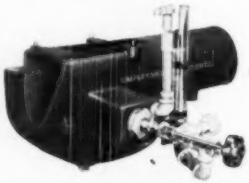
...about how to measure

TRADE WASTES?

In accordance with anti-pollution laws recently enacted by numerous states, most industries now face the task of purifying their plant wastes before discharging them into adjacent streams and rivers.

This purification process usually requires special plant construction, and invariably the necessity exists of obtaining flow data, whether this be the simple indication of flow rate or a more permanent method of recording and totalizing the flow through the plant. With purification processes of this kind, measuring equipment usually is located at the point of discharge of partially filled pipe or in open channels, where low heads or pressures exist and where measurement is either difficult or impossible when using standard forms of measuring instruments.

The Simplex type S Parabolic flume, either alone or in conjunction with a Simplex type HF water float operated meter, is the ready answer to this measuring problem. Compact in design, with no pockets or grooves to catch sediment or solids, and capable of operating under low flow conditions, the unit measures over long ranges, from maximum to 5% of maximum capacity.



Available in standard pipe sizes of 6 inches to 36 inches diameter inclusive, the flume can be attached to even larger sizes by means of eccentric reducers.

Send for Bulletin 210, to the Simplex Valve & Meter Company, 6780 Upland Street, Philadelphia 42, Pennsylvania.

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VALVE AND METER COMPANY

representing expenditures of over $35,000,000, are listed by title.

The hundreds of subjects include: air compressors, air conditioning, air cooling, air distribution, high-temperature alloys, coal, compressors, corrosion, electric machinery, diesel engines, fluid flow, fuels, gas turbines (16 projects), heat pumps, heat transfer (42 projects), steam heating, instruments (18 projects), isotopes, pumps, steam turbines.

THE COLUMBIA: POWER HOUSE OF THE WEST (1949). *By Murray Morgan. 295 pp, 5½x8 in. illust, cloth. $3.50. Superior Publishing Co, 2603 3rd Ave, Seattle 1, Wash.*

Plans to develop the Columbia River in the U.S. include nearly 200 hydroelectric projects with a combined capacity of 20 million hp. If we include the power that can be produced on its Canadian portion, a total capacity of over 25 million hp can be installed. This is equal to all hydroelectric turbines in the U.S. No wonder, then, the author calls the Columbia River "The Power House of the West."

Engineers and laymen alike will find here not only much information on the river's power possibilities, but also its economic significance to the U.S. Pacific Northwest and to Canada. The author has explored the river from its source in Columbia Lake in British Columbia, 2652 ft above sea level, to the dangerous sand bars at Cape Disappointment, where each year it pours its millions of acre-feet of water into the Pacific.

The volume is divided into five sections: Where flows the Oregon. The untamed river, The working river, The tidal river, and The river of the future. In these divisions are covered its geography, geology, history, power developments and economic possibilities.

DE LAVAL ENGINEERING HANDBOOK. *Edited by Austin H Church and Hans Gartmann. 255 pp, 5½x7¾ in. illust, many tables and charts, fabroid. $2. De Laval Steam Turbine Co, Trenton 2, N. J.*

The handbook was originally published in 1947 in a limited edition. This revision is now available for general distribution. It contains information and formulas useful to power-plant, industrial and consulting engineers.

Material is divided into: steam turbines, centrifugal pumps, Imo pumps, compressors, blowers and exhausters, helical reduction gears and wormgear speed reducers. These six sections are preceded by a 100-page section of mathematical, mechanical and fluid information applying to the sections named. Tables include functions of numbers, conversion factors, properties of sections and beam formulas, horsepower curves of shafts and leather belts, dimensions of pipes and flanges, properties of water and steam, friction of water in pipes, and other data. Treatment is practical, giving the information necessary to understand the equipment described and how to apply and operate it.

HEATING, VENTILATING AND AIR-CONDITIONING FUNDAMENTALS (*2nd edition-1949*) *by W H Severns and J R Fellows, professors of mechanical engineering, Univ of Illinois. 666 pp. 6x9½, 375 illust, 134 tables, cloth.*

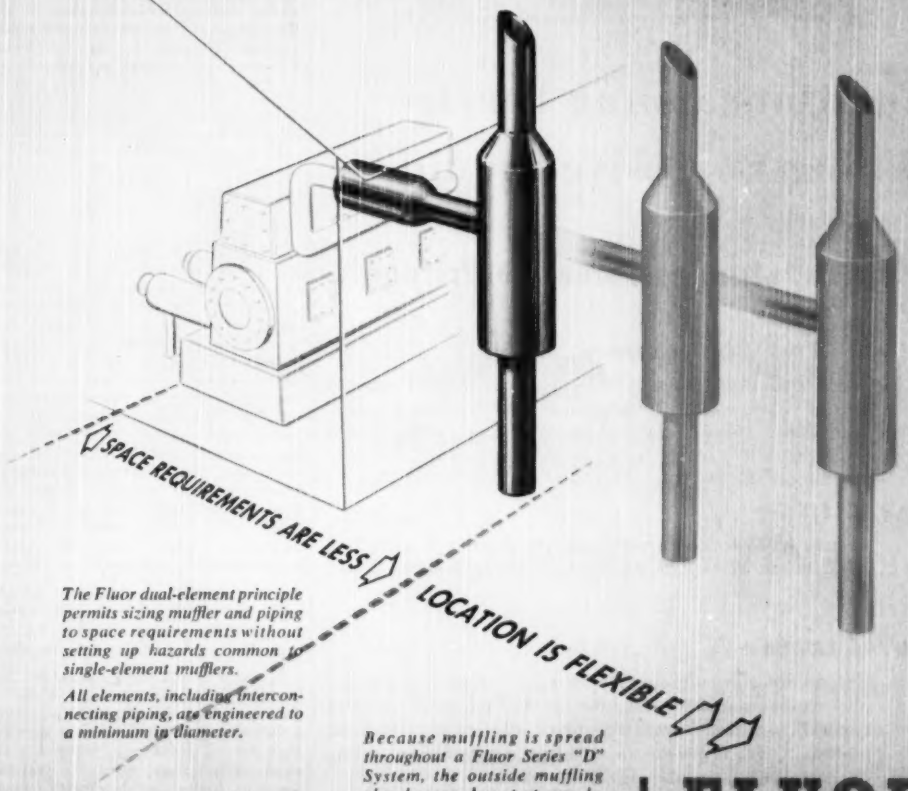
See for yourself...

the installation advantages of a FLUOR SERIES "D" MUFFLER SYSTEM

NO LONGER is ultimate muffling efficiency dependent upon trial-and-error locating of exhaust piping. With the Fluor Series "D," exhaust piping can be of *smaller* diameter, location of outside exhaust chamber *flexible* without affecting pressure drop or noise attenuation and pulsation reduction efficiency.

The reason lies in the unique dual-element design of this muffler *system*. Work is started on pulsative exhaust gases *at* the engine—noise and pulsation reflections are virtually eliminated *at* their source. The Fluor Series "D" Muffler is a *system* that incorporates *two* muffling elements—a primary element located in the immediate proximity of the engine and a secondary element located *at any desired spot* outside the engine room.

The Fluor Series "D" Muffler System is the answer to your muffling problems. In addition to installation flexibility it provides the highest muffling efficiency obtainable—*at a cost competitive with conventional mufflers.*



The Fluor dual-element principle permits sizing muffler and piping to space requirements without setting up hazards common to single-element mufflers.

All elements, including interconnecting piping, are engineered to a minimum in diameter.

Because muffling is spread throughout a Fluor Series "D" System, the outside muffling chamber can be set at any desired distance from the engine room wall.

AVAILABLE FROM STOCK—A Fluor Series "D" Muffler System to fit virtually any 2- or 4-cycle, 200 to 2400 HP diesel engine is available from stock. You need only submit engine room design and dimensions, make, model and RPM of engine and whether muffling system is to be air-cooled or non-air-cooled. Inquiries will be answered promptly.

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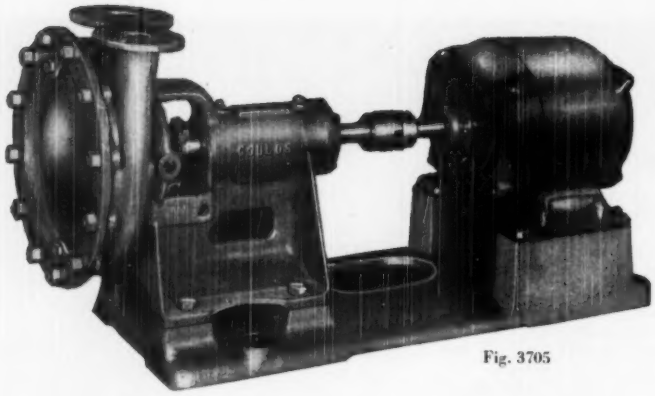

Fig. 3705

For Outstanding Service Handling Corrosive Liquids—

Goulds new stainless steel centrifugals

ADVANCED PUMP DESIGN—

The Goulds 3705 stainless line represents the last word in effective design. Fig. 3705 pumps will give you efficient, dependable, 24-hour service in handling corrosive liquids—at low cost.

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Goulds stainless steel centrifugals are made in 8 sizes with capacities to 750 G.P.M. and heads to 180 ft. depending upon capacity.

ADVANTAGES—

Exceptional efficiency (see Bulletin for performance curves) plus extreme simplicity make this an ideal pump for corrosive applications. High interchangeability of parts cuts stocking problem. Quick inspection or cleaning—simply remove casing cover without disturbing pipe connections.

MEMBER

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Goulds PUMPS INC.
Seneca Falls
New York

$6.50. *John Wiley & Sons, 440 Fourth Ave, New York 16, N. Y.*

The authors keep in mind their audience—engineers, architects, heating contractors, students. So behind every discussion is the basic theory that applies. Then accepted commercial practices follow.

The second edition brings to attention results of more recent application and research programs as well as new equipment growing out of these programs. Sample calculations are helpful to students and engineers in understanding either the application or theory behind equipment choice.

Highlights are (1) enlarged and rearranged presentation (2) about 200 pages of new material covering warm-air furnace heating, hot-water heating, panel heating, refrigeration, air purification, estimation of cooling loads and air conditioning (3) new illustrations (4) specific data and design methods for panel heating (5) design procedure for summer and all-year air conditioning.

STEAM, AIR, AND GAS POWER (*4th edition*). *By W H Severns, professor of mechanical engineering, University of Illinois, and H E Degler, technical director, Marley Co.* 509 *pp.* 230 *illust,* 19 *tables,* 6x9. $4.75. *John Wiley & Sons, Inc.* 440 *Fourth Ave, New York* 16, *N. Y.*

This elementary textbook deals with heat engineering for limited courses of study, which precludes an exhaustive coverage of all phases of the subject. Representative equipment and their theory of operation are described. Fundamental theories of heat power are the same as in previous editions. This revision brings the practical applications up to date and makes the material more understandable by rearrangement of the presentation. Chapter headings are: Plants, Thermodynamics, Steam, Fuels and Combustion, Steam Generators, Auxiliaries, Feedwater, Draft Apparatus, Steam Engines, Steam Engine Power and Economy, Steam and Gas Turbines, Condensing Equipment, Pumps, Compressed Air, Internal-Combustion Engines.

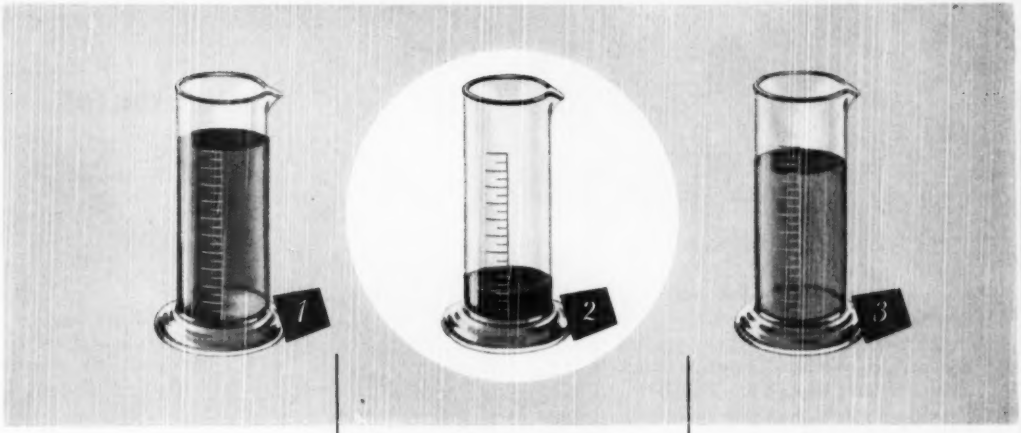
THE ELECTRIC POWER INDUSTRY. *By editorial staff of "Electrical World."* 178 *pp,* 11¼x9. $3.50. *McGraw-Hill Book Co,* 330 *West* 42*nd St, New York* 18, *N. Y.*

In this book, editorial content of the 75th anniversary issue of *Electrical World* is given permanent form that will physically withstand much usage. As the subtitle, *Past, Present and Future,* indicates it reviews the status and history of electrical power generation and distribution. Highlights of the various fields in the industry are given for Power Stations, Station Generation, Transmission, General System Techniques, Distribution, Maintenance and Metering, Use of Electricity and Industry Organizations.

At some points comparisons are made between domestic and foreign practice and developments. The part our industry has played in supplying components for systems of other countries is related. Over two dozen practicing engineers have contributed to the volume.

ELEMENTS OF THERMODYNAMICS AND HEAT TRANSFER. *By E F Obert, associate profes-*

How Alchlor Process "Remove-ability"* gives Gulfcrest Oil its greater stability



In Cylinder 1 you see the oil that will become Gulfcrest. It has gone through the usual steps used in refining most other turbine oils—but has not yet been Alchlor-processed — an extra refining step that makes it extra pure and extra efficient.

* In Cylinder 2 you see the part—as much as 15%—which is discarded by the Alchlor Process. This is the part that, in ordinary turbine oils, is most likely to oxidize, increase neutralization number, and form sludge, emulsifiers, and acids.

In Cylinder 3 you see the finished Gulfcrest—the incomparably pure lubricating oil that gives outstanding performance and helps you keep steam turbine systems clean indefinitely. To make it even finer, special inhibitors are added to it.

Call in a Gulf Lubrication Engineer today and ask him to recommend the proper grade of Gulfcrest Oil to meet the specific requirements of your turbines. Write, wire, or phone your nearest Gulf office.

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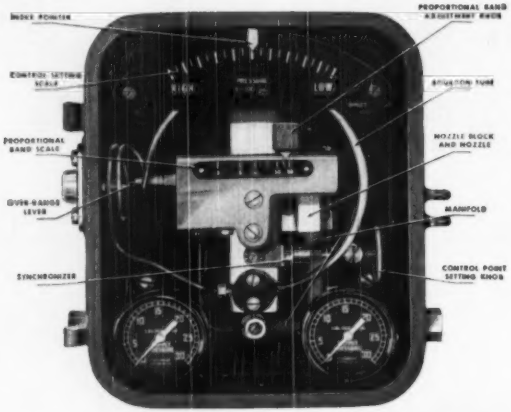
That Provide Precise Control at Moderate Cost

In a Majority of Pressure Applications
In Many Temperature Applications



The majority of industrial pressure control applications and many temperature applications can be satisfactorily handled by a simple pneumatic proportional controller with narrow-to-intermediate proportional band setting. Models 2700 Pressure and 3700 Temperature Controllers have been designed to meet these requirements at moderate cost without sacrifice of performance, precise proportional response or ease of adjustment.

The controllers are furnished with universal case or wall or panel mounting. A wide selection of pressure and temperature ranges is available.

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Temperature Controller

NOTE THESE FEATURES...

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2. Pneumatic feedback — usually found only in more expensive proportional controllers . . . precise response.
3. Control point setting mechanism provides extreme accuracy of adjustment and easily read expanded index scale.
4. Proportional band adjustment between 3 and 50%.
5. Compact and sturdy case and internal mechanisms; all important internal parts of bronze, brass or 18-8 stainless steel.
6. Control action reversible with either bourdon or bellows.

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sor of mechanical engineering, Northwestern University. 372 pp, illust, tables, charts, 6x9. $4.50. McGraw-Hill Book Co, 330 West 42nd St, New York 18, N. Y.

This book serves as the text for undergraduate courses in thermodynamics and heat transfer for engineering students. The author aims at making the presentation simple and direct without sacrificing accuracy and thoroughness. Definitions are emphasized first to form the subject foundation. Upon this is built the First Law, the principle of reversibility and the Second Law. With these as the basic working tools the properties of real fluids, the characteristics of real gases and the concept of the perfect gas are discussed. The student is then ready to study the applications of thermodynamics that follow.

Text stresses actual machines, flow processes, properties of fluids and the conditions where simplified analyses can be applied. Fluid flow has been emphasized as well as heat transfer because of their practical importance to the engineer.

PLANT PROBLEMS

(*Continued from page* 132)

mum flow. This takes care of the high condensation rate when steam is first turned on and the kettle is cold. *CP* should consult a handbook for steam-flow formula.

IRA A BUTCHER *Piney River, Va.*

About a 4-in. Pipeline

I ASSUME *CP's* vat is insulated and has a vented cover to prevent pressure buildup. No mention is made of pressure, temperature and type of steam available (live or exhaust). So let's say the plant generates steam for processing only, and assume steam entering the kettle jacket is of 95% quality, 217 F, 1.5 psig.

Assume specific heat of malt and corn grits is 1. We can then deal with a total weight of 25,000 lb water. First heat requires 1,125,000 Btu for 15 min. Heat through insulation is small—about 51,800 Btu per hr or 12,950 Btu for 15 min. Total heat is then 1,131,950 Btu for 15 min.

Since our steam has a 95% quality, we actually need 4940 lb per hr. Likewise for the second heat, 158 F to 212 F, 1,350,000 Btu for the liquid, plus 17,250 Btu loss or 1,367,250 Btu total. Weight of steam is then 4450 lb per hr. Heat loss during half-hour holding period is negligible.

If two traps are used, each should be able to handle about 1½ times the steam condensation. Or in this case, a capacity of 6000 lb per hr for each trap.

At a flow of 5000 lb per hr, a 4-in. pipe gives a pressure drop of about 4 psi per 100-foot run of straight pipe. On this basis, for a 100-foot run from

THE JEFFREY MANUFACTURING COMPANY
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Complete Line of Material Handling, Processing and Mining Equipment

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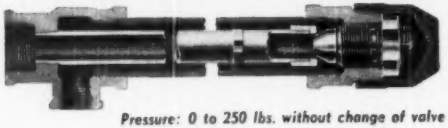

Pressure: 0 to 250 lbs. without change of valve or seat.

Length: 18" to 40": thermostatic, continuous flow.

Easily Installed, Low Cost

Because valve is easily adjusted to pass condensate at any temperature below 212° F., these traps are also widely used for regulating temperature of equipment.

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CATALOG 488
or see Sweet's

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McKEES ROCKS, PA. (Pittsburgh District)

header to kettle, boiler would have to develop about 6 psig.

NORTON SAVAGE *Philadelphia, Pa.*

Provide Vat Air-Vent

ASSUME STEEL PLATES ¼-in. thick in kettle. This runs about 10 lb per sq ft and has a specific heat of .150. Specific heats for malt and grits may run from 0.25 to 0.50. Assume a specific heat of .35 for the contents.

Simplest way of handling the problem is to find the "water equivalent" of the corn, malt, and the steel vessel. This, plus weight of water, gives a total of 23,535 lb. Continuing along this vein we find trap load under 6000 lb of condensate per hour. Double this figure and select a trap capable of handling 12,000 lb per hour. Using 100-psig steam, about a 4-in. steam main would be required.

This service is classed as a "quick-heat" process; hence a combination float and thermostatic steam trap should be used. This is needed since vat will discharge condensate as fast as it forms and at a temperature only slightly less than steam temperature. Bucket or thermostatic traps give intermittent discharge and so cause some collection of condensate ahead of trap with a possible flooding of a portion of vessel heating surface.

No mention was made about point of steam admission to kettle or point of condensate drainage. We assume steam is admitted near top of jacket and condensate is drained near bottom. Some provision must be made to remove air from jacket especially at startup. Air vents should be located opposite point of steam admission in direction of steam flow. If steam is admitted on one side of jacket, air vents should be on opposite side. Air vents should be thermostatic type that closes when live steam reaches vent.

C E BRAKENRIDGE *Buffalo, N.Y.*

Discharge to Flash Tank

FOLLOWING FORMULA gives a close figure on weight of steam condensed per hr: $C = W \times (t_1 - t_2)\ S \div L$, where C is steam condensed per hour; W is weight of vat or contents in pounds; t_1, final temperature; t_2, initial temperature. Then S is specific heat of substance, and L the latent heat of steam. Working this out for both vat and contents, total condensate per hour is 10,860 lb.

Two traps should be used having a capacity of 7722 lb per hr. This is preferable to one large trap of 55 lb per sq ft.

Steam-supply pipe should be 6 in. in dia, and branched near vat with 2-in. pipes fitted with stop and control valves. Trap discharge should be led to a flash tank equipped with vent with check

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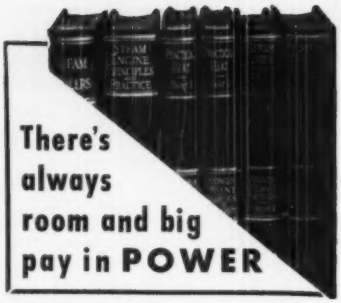

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valve to atmosphere. Tank contents should be led to open heater of vacuum-pump suction.

JOHN M GORRIE *Lansing, Mich.*

Flow: About 5000 Btu/Hr

CP WON'T BE TOO FAR OFF if he assumes specific heats of the mixture constituents as equal to that of water, or unity. Hence, he must supply 25,000 (1.0) (45 F) = 1,125,000 Btu in 15 min to raise mixture temperature from 113 to 158 F. During the holding period, heat is lost to the surrounding atmosphere; so steam must be supplied to maintain vat contents at 158 F. Heat lost by radiation, assuming vat wall at 170 F and room at 70 F = 1.0 (325 sq ft) (100 F) = 32,500 Btu per hr. Convection loss = 0.81 (325 sq ft) (100 F) = 25,500 Btu per hr. Radiation and convection calculations are based on *Heat Transmission*, McAdams, McGraw-Hill Book Co. Though the last two calculations are approximate, they show *CP* can neglect the holding period.

Second heat requires 25,000 (1.0) (54 F) = 1,350,000 Btu. Since second heat requires more heat energy than the other two, piping and traps that can handle this load will be suitable for the smaller ones also. Assuming about 10% of the heat supplied by the steam is lost by radiation and convection, total number of Btu required is 1,500,000.

If high-pressure saturated steam is used for heating without any subcooling of the condensate, more will be required because the latent heat is less than for low-pressure steam. But the steam pressure must be high enough to produce a sufficient temperature differential across the 233 sq ft of heating surface. A minimum difference of about 25 F is usually necessary but *CP* can use a higher value if he cares to. Since the second heat lasts 20 min. maximum Btu required in an hour is 3(1,500,000) = 4,500,000. With steam at 25 psia, flow required = 4,500,000 ÷ 952 = 4830 lb/hr, say, 5000 lb/hr. It appears that *CP* will have to size his piping for approximately this flow, regardless of what assumptions he makes for heat losses and specific heat of the mixture.

For a 2.0-psi pressure drop per 100 ft, a 4-in. steam line would be satisfactory. To be on the safe side, *CP* should use two 1½-in. return lines. Two traps, each with a capacity of about 3500 lb per hr would be suitable. These traps should be fitted with an air-relief device or an air-relief valve fitted on the vat. *CP* should be most careful when selecting supply and return-pipe sizes because undersized piping will reduce vat-cooking capacity. Radiation and convection losses should be based on the total outside area of the vat, not on the jacket area alone.

TYLER G HICKS *Summit, N.Y.*

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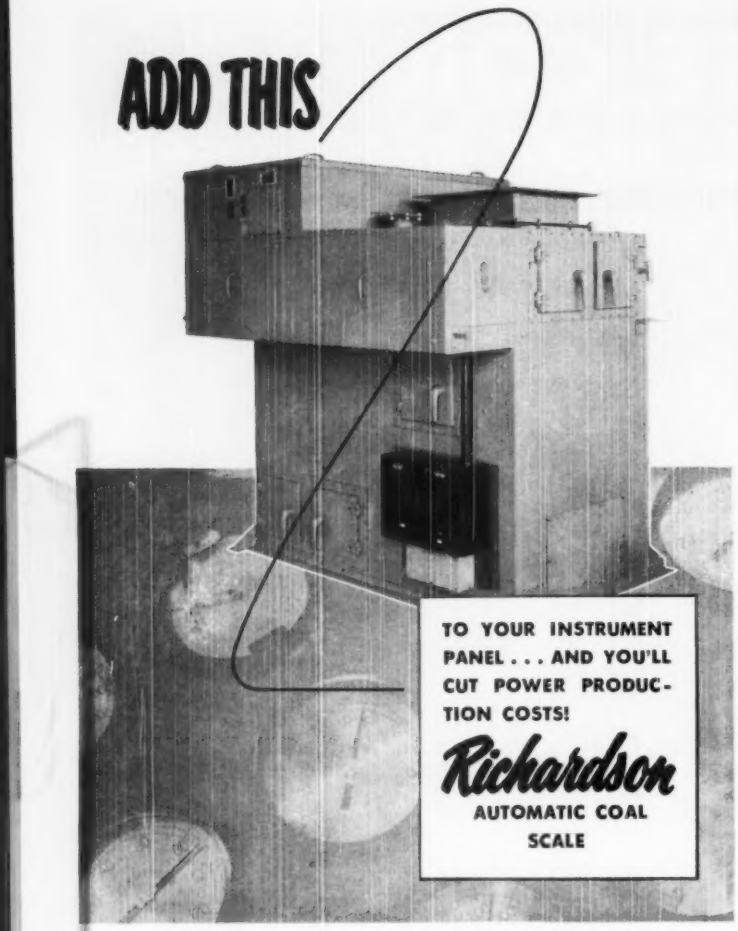

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NEW EQUIPMENT

(*Continued from page* 150)

the water enter the cooling portion of the tower. Cascade deck surfaces break the fall of the water and set up a filming action for effective heat transfer.

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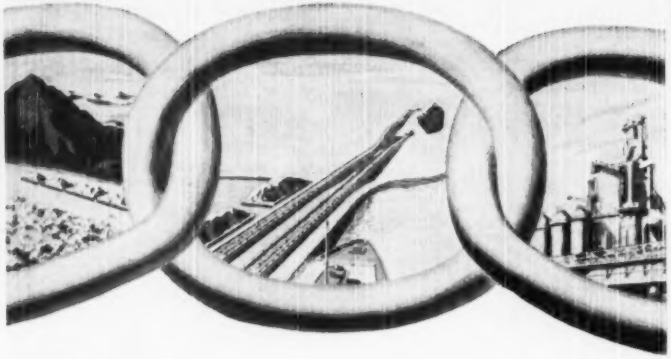

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North America needed additional sources of iron ore to feed her hungry blast furnaces. South America had that ore. For example, up the Orinoco River valley, in Venezuela, there is a huge mountain of it.

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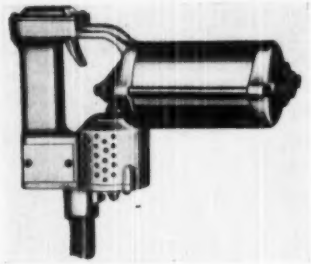

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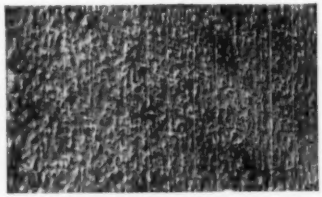

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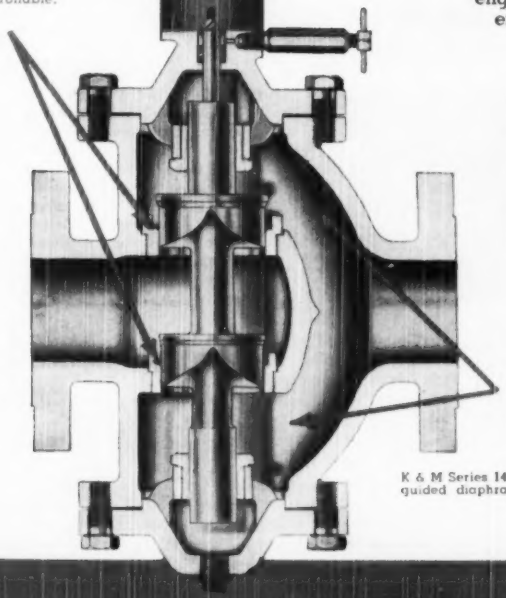

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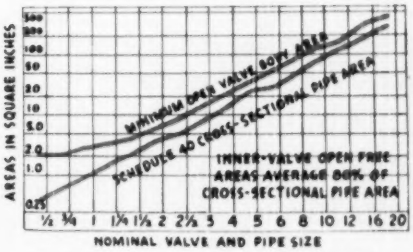

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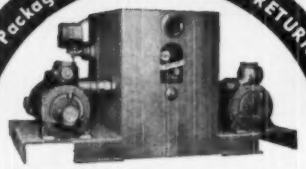

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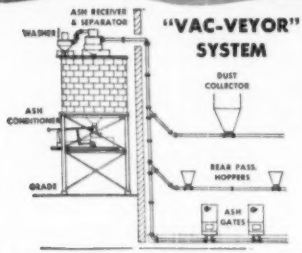
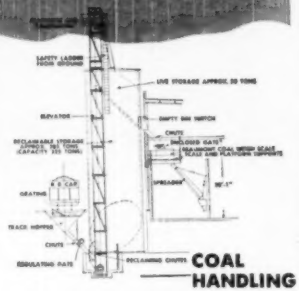


"VAC-VEYOR" SYSTEM

In this system, ashes, siftings, soot and dust are conveyed by pipe from the ash pits, dust collectors, stack, etc., to an ash receiver and separator at the top side of a silo—by means of a vacuum. One man operates the system, keeping your plant cleaner with less labor. Send for Catalog.



COAL HANDLING

Coal arrives by rail, is dumped into hopper, raised by bucket elevator and discharged either into bunker for immediate use or down chute to yard storage. One operator controls all equipment. Send for Catalog.

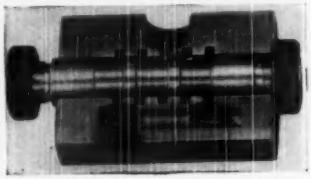
BEAUMONT BIRCH Company

1502 RACE STREET—PHILADELPHIA 2, PENNA.

Designers Manufacturers Erectors BULK MATERIAL HANDLING SYSTEM

flame cut. Plates are ⅛ to ⅜ in. thick, 60 in. wide, maximum, by 144 in. long.

Alan Wood Steel Co, Dept W-100, Conshohocken, Pa.



AIR VALVES **P238**

Hi-Cyclic air valves will control the stroke of an air cylinder within 0.001 in., stop and return the stroke at any point without overtravel, control stroke speed in either direction, reciprocate mechanically or electrically and control the pressure in both ends of the cylinder, says the manufacturer.

Valve operates on air-line pressure as low as 1 psi, or as high as can be delivered to it. Can also work efficiently on 1 in. of vacuum. The *Hi-Cyclic* solenoid valves have no linkage or mechanical lag time and operate as fast as is electrically possible. *Model B*, ⅛ and ¼-in. valves are 3 in. long, 2 1/16 in. wide and 2 7/16 in. high.

Model B-2 double solenoid valve is 9¾ in. long, 3 1/16 in. wide, and 5 5/16 in. high.

Beckett-Harcum Co, Wayne Road, Wilmington, Ohio

CENTRIFUGAL PUMP **P203**

Two-stage volute design has watercooled duplex angular-contact ball thrust bearing, labyrinth impeller seals, heavy horizontally-split casing with flanged bearing supports, inter-stage seal against bypassing, only suction pressure on both stuffing boxes, renewable shaft sleeves, back-to-back impeller to give hydraulic balance. Capacities range up to 825 gpm and heads to 800 ft.

Warren Steam Pump Co., Warren, Mass.

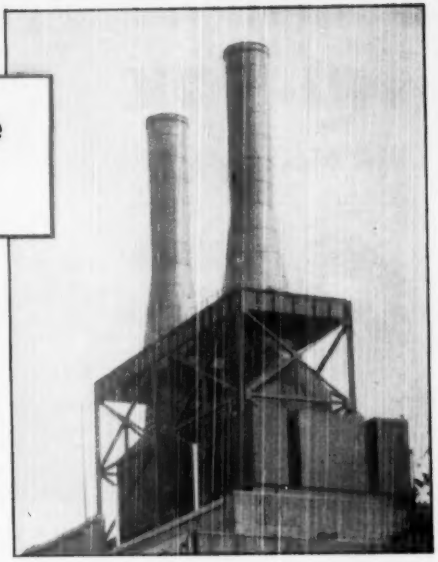
SCALE INDICATOR **P210**

Electrical instrument is said to measure thickness of scale or other deposit on the inside of boiler tubes or circular cross-section ducts.

Electromagnetic probe head enters tube where it is held against tube sides by guide wheels. A graduated spring steel tape feeds the probe down the tube length. Head can be rotated or locked in position as desired.

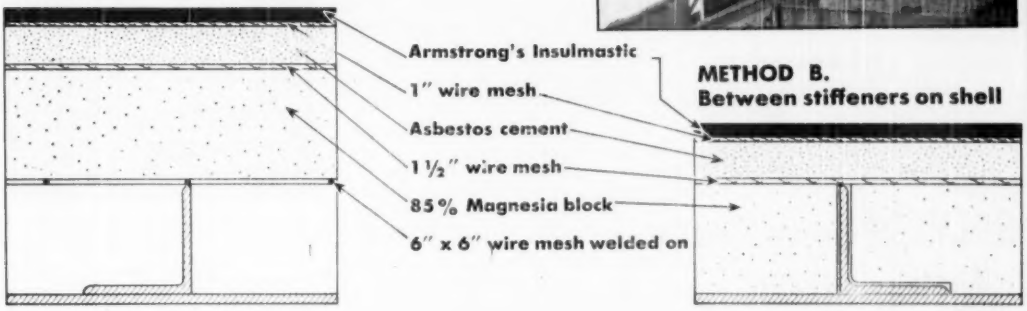
The two feet in the probe head bear

How would you insulate these dust collectors?



To prevent moisture condensation and corrosion inside these dust collectors, they are to be insulated with a layer of 1½" thick 85% Magnesia. How would you apply the insulation?

METHOD A.
Over stiffeners on collector shell



Here's what the Armstrong engineer recommended:

Of the two methods shown above, the application of the insulation over the stiffeners is most practical. The insulation is applied over 6" x 6" wire mesh, welded to the stiffeners. This mesh absorbs considerable "weave" and guards against the insulation's cracking as the collectors expand and contract. Also, the cost of applying the insulation over the wire mesh is lower than fitting insulation between the stiffener angles.

Method A also has the advantage of providing full insulation protection over the entire surface. In method B, the only protection over the stiffener is the wire mesh, plaster, and Insulmastic finish. The "weave" of the collectors will cause cracking at these points.

Helping you arrive at the most practical solution to any heat insulation problem is part of the day-to-day job of Armstrong engineers. In addition to this engineering help, Armstrong's Contract Service provides you with top-quality insulating materials and skilled workmen to apply them. The next time you need heat insulation to save fuel or to improve the operation of a piece of equipment, call the Armstrong District Office nearest you for full information.

NEW BOOKLET—Send today for your free copy of "Armstrong's Industrial Insulations." It contains valuable information on heat insulations, recommended thicknesses, and proper methods of application. Write to Armstrong Cork Co., 7002 Maple Ave., Lancaster, Pa.

ARMSTRONG'S INDUSTRIAL INSULATIONS

MATERIALS Ⓐ INSTALLATION

FOR ALL TEMPERATURES FROM 300° F. BELOW ZERO TO 2800° F.

For STRENGTH specify

TRI-LOK

RECTANGULAR

OPEN STEEL FLOORING

The locked-in strength of Tri-Lok enables it to stand up under heavy loads—even on long spans. No rivets, bolts, or welds are used in the construction of Tri-Lok; this feature eliminates the possibility of loose joints.

Tri-Lok is also available in Diagonal, or Super-Safety U-type Flooring, and in Stair Treads of all types. Write for Bulletin KM 1140.

DRAVO CORPORATION

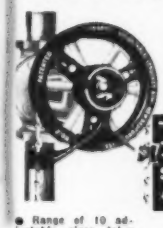
National Distributor for the Tri-Lok Company

Drave Bldg., Pittsburgh 22, Pa.

Sales Representatives in Principal Cities

DRAVO

SOLVED! An Overhead PIPING PROBLEM



Babbitt —Adjustable— SPROCKET RIM with Chain Guide

● Range of 10 adjustable sizes takes care of all valve makes and types; fits valve wheel diameters from 2 to 30 inches.

● Operation of valves in overhead piping is no longer a problem. Put valves where they should be, where they'll be most economical or efficient, even if necessary to place them out of reach. Easy, safe, positive control is provided by the BABBITT Adjustable Sprocket Rim with Chain Guide—right from the floor!

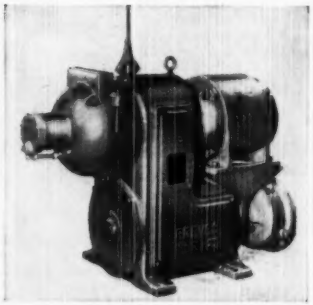
● The BABBITT Adjustable Rim fits all valves, with either rising or non-rising stems. It is installed quickly by clamping onto the hand wheel of the valve.

● *Write today for Catalog Bulletin P, surprisingly low prices, and name of nearest distributor.*

BABBITT STEAM SPECIALTY CO.

1 Babbitt Square, New Bedford, Mass.

against the face of the tube and indicate the distance in thousandths of an inch between the feet and the tube metal. Wall thickness has no effect on meter accuracy. **Haskins Turner Co, 1617 Third St, Jackson, Mich.**

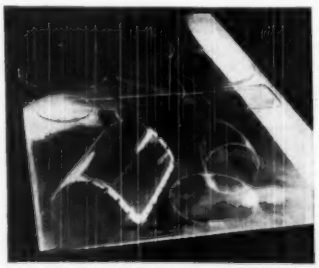


HYDRAULIC CONTROL P207

For adjusting the output speed of a motor-driven variable-speed transmission, this hydraulic control provides a sensitive and accurate means of obtaining automatic speed change. It can automatically control tension, speed, pressure, temperature, liquid level of materials in process, or synchronize speed of production machine or of parts of a unit.

Control-valve lever may be actuated from any speed-indicating mechanism on the driven machine, such as a floating roll, follower roll, temperature or pressure indicator, float or other moving parts. A pressure of only a few ounces will change output speed.

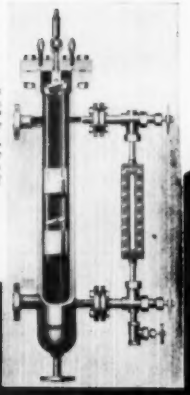
The variable-speed drive combines in one unit a motor, speed-changing mechanism and gear reducer. The control consists of a self-contained hydraulic power plant and a simple rotary valve, piston and cylinder, in one case mounted on the drive in place of the customary control handwheel. This control without the hydraulic plant is available for pneumatic operation. In these applications a compressed-air supply is connected to the rotary valve. **Reeves Pulley Co, Columbus, Ind.**



TRANSPARENT PLASTIC P212

Thermosetting, noncrazing, transparent plastic, *Sierracin 212*, stays strong at low and high temperatures, withstands rapid changes in temperature and pressure.

Physical properties have remained consistent from one batch to another with less



Jerguson Water Column with 7-HP Gage and A-37 Drain Valve. Available complete, or as individual units.

JERGUSON WATER COLUMNS Give Positive Alarm Signals

Keen Knife-Edge Balance Holds Key To Outstanding Jerguson Performance

YOU'RE sure of positive boiler alarms with JERGUSON WATER COLUMNS . . . because keen *knife-edge balance* assures immediate action.

Positive action is necessary when boiler water level falls too low or rises too high in your boiler. Jerguson's camshaft arrangement exerts sufficient force to give the power to assure action under all conditions. The warning whistle blows *immediately* when the limit is reached in either direction.

The alarm mechanism on JERGUSON WATER COLUMNS is stainless steel throughout. Valve stem, cam, and knife edges are carefully hardened. A complete range of pressures and sizes, with screwed, flanged, or welding connections. There's a dependable JERGUSON WATER COLUMN to fit your requirements.

Write today, without obligation, for complete DATA UNIT on Jerguson Water Columns

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY

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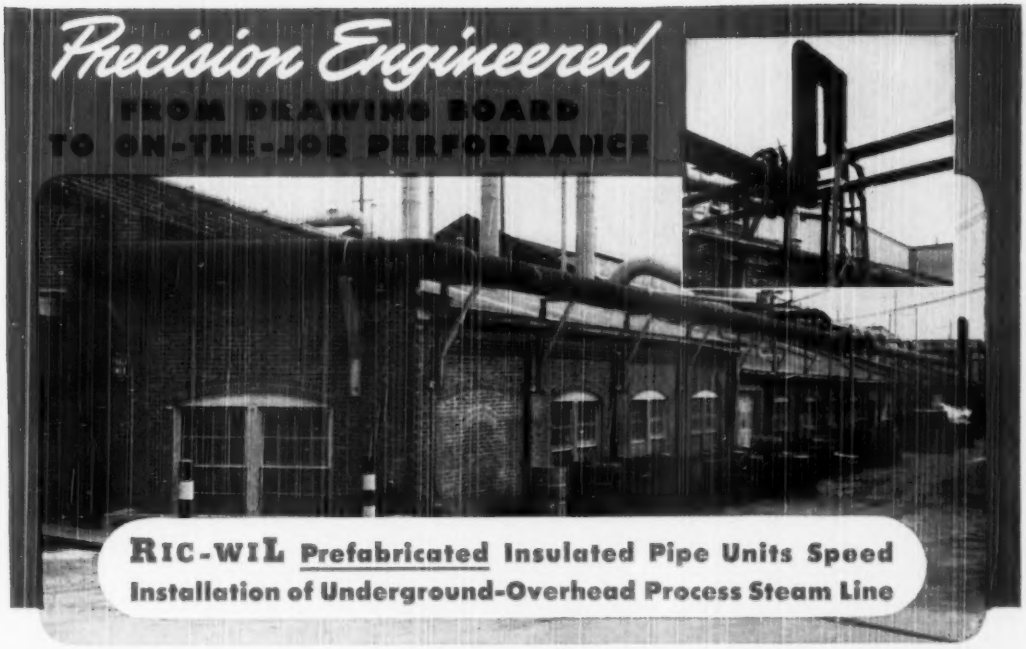
Precision Engineered

FROM DRAWING BOARD TO ON-THE-JOB PERFORMANCE



RIC-WIL Prefabricated Insulated Pipe Units Speed Installation of Underground-Overhead Process Steam Line

A PROCESS STEAM LINE recently installed at a large adhesives manufacturing plant demonstrates many of the outstanding advantages of Ric-wiL *Prefabricated* Insulated Piping Systems.

Process steam leaving the boiler head at 145 psi is delivered to the adhesives mixers—a key operation—by a line constructed of Ric-wiL Hel-cor Pipe Units carrying an 8" steam pipe and 3" condensate return. Both pipes are insulated and housed in the same conduit, which runs underground beneath two railroad tracks and a concrete roadway as well as overhead between and alongside various plant buildings.

All units, accessories and sub-assemblies were accurately prefabricated at the Ric-wiL factory to individual specifications of this installation. With the complete system and all details laid out on the drawing board, pipes were cut to precise lengths required and each component unit was precision prefabricated. Each unit was identified for its exact position in the system, ready for single handling installation upon delivery, with a minimum of field work and time required.

The inherent flexibility of Ric-wiL Insulated Pipe Units makes it possible to provide adequate compensation for stresses and reactions caused by expansion, using a minimum of expansion devices. Only one expansion loop was required for this installation since a substantial portion of the expansion was absorbed in directional changes of the line.

Precision prefabrication, protection and insulation by Ric-wiL time-proved methods assure piping systems of high thermal efficiency, corrosion resistance, durability and strength, coupled with speedy, low-cost installation.

★ **Ric-wiL Prefabricated Insulated Piping Systems are made-to-order for distribution piping of process liquids, viscous fluids, oil, refrigerants, steam, hot or cold water. Ric-wiL engineers will be glad to consult with you on your insulated piping problems —without charge or obligation. For full information write The Ric-wiL Co., Dept. 5X.** ★

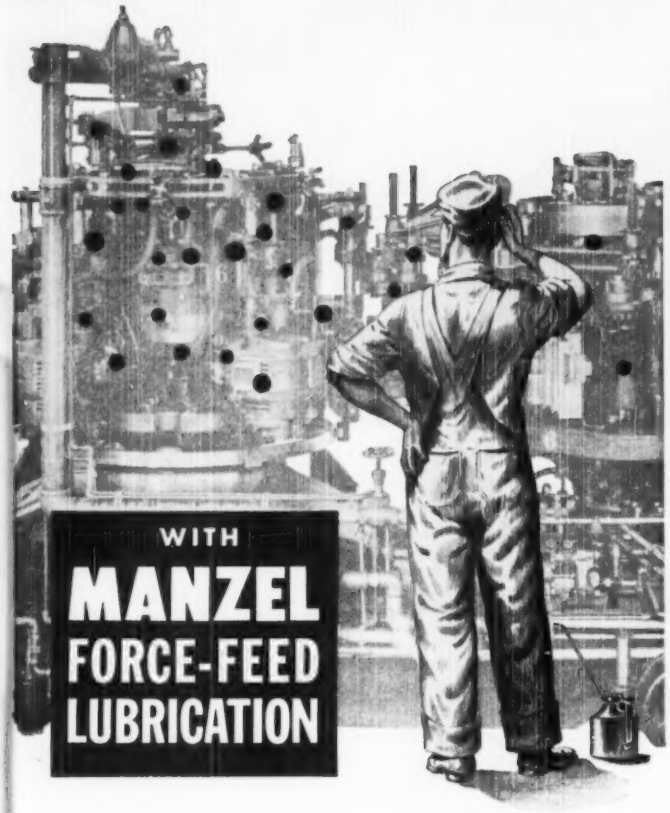
RIC-WIL

INSULATED PIPING SYSTEMS

THE RIC-WIL COMPANY • CLEVELAND, OHIO

REPRESENTATIVES IN PRINCIPAL CITIES

CORRECT THESE SPOTS BEFORE HIS EYES!



WITH

MANZEL FORCE-FEED LUBRICATION

MANY spots requiring many different amounts of lubricant make it easy for a new man (or even an experienced one) to get all mixed up.

Manzel Force Feed Lubricators eliminate not only the confusion—but also the workman. For Manzels automatically lubricate any number of wearing points—no matter how hard to get at. Just enough of the right type of lubricant is always at each point.

Manzel Force Feed Lubricators save the initial cost many times over each year. They are supplied as standard equipment on various makes of engines, pumps, compressors, and other heavy machinery. Or they can be installed on your present equipment.

A Manzel representative will gladly give you technical assistance on your lubrication problem.

Write us now.

Manzel Inc. now supplies repair parts for all models of Bowser and Torrington Lubricators.

Builders of HIGH PRESSURE METERING PUMPS Since 1898

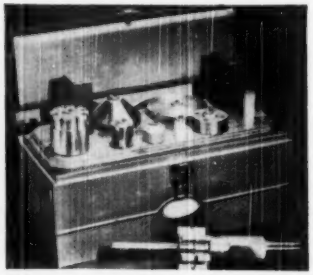
A Subsidiary of Frontier Industries, Inc.

Manzel INC.

Babcock Street Buffalo 10, N. Y.

than 2% of variation on tensile, flexural, elongation and Barcol hardness tests. Sierracin may be machined easily by all standard machinery methods. It lends itself particularly well to dry grinding with standard resinoid bonded wheels. The material may be permanently cemented together or to others such as metal, wood, glass, plastic, etc.

Sierra Products Co, 1632 E Compton Blvd, Route 1, Compton, Calif.



WORKHOLDING TOOL **P219**

Time-saving, precision tool, *In-R-Tool*, is a workholding device that can be quickly used in lathes, vises, boring mills, on machine tables and in fixtures.

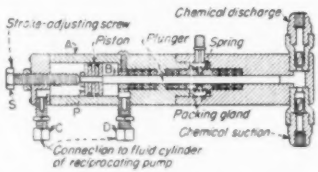
It is primarily an expanding arbor with a number of applications. Cores and pressure members that fit the splines of the core are interchangeable. The cores have a range from 1¼ to 2¾ in. and have national coarse ¾-10 precision threads. A ratio-limiting collar controls distortion of thin work. This collar regulates expansion of the pressure members and they, in turn, hold the work firmly and accurately in place.

Layne-Held Corp, 2007-H South Shelby St, Higginsville, Mo.

MEGOHMMETER **P253**

An instrument designed for measurement of electrical resistance over a range from 300,000 ohms to 20,000,000 megohms. Power supply for this instrument is from 110 to 115 v, and 190 to 260 v ac source. There are two test potentials of 85 and 500 v dc.

Herman H Sticht Co, Inc, 27 Park Place, New York, N. Y.

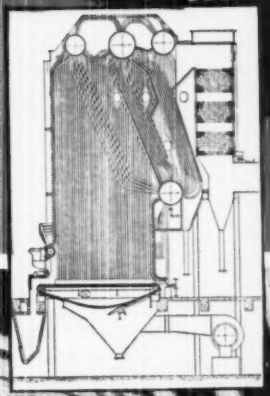


CHEMICAL FEED PUMPS **P208**

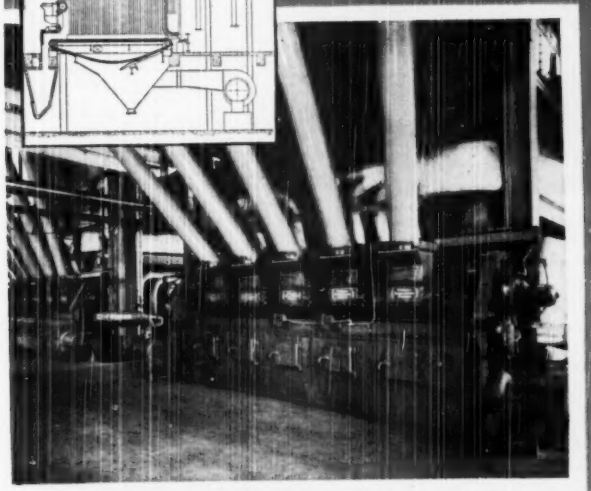
Designed to be driven from the fluid end of a reciprocating pump this *Nelson* chemical-feed unit makes stroke for stroke with the main pump. So it delivers chemicals into the discharge line proportional to the reciprocating pump's speed.

The chemical pump has a power cylinder *A* in which a piston *P* connects to chem-

DETROIT ROTOGRATE STOKERS
Will Cut the Cost of Producing Steam In These Paper Mills



150,000 pound units with Detroit RotoGrate Stokers—Consolidated Paper Company, South Side Plant, Monroe, Michigan.



Fuel economy and recognized ability to handle high capacities and widely fluctuating loads has made the Detroit RotoGrate Stoker popular with Paper Mills.

A spreader type with grates that move slowly forward to continuously discharge the ash at the front. Successfully burns all grades of coal and Lignites. No special fuel preparation necessary.

Backed by over ten years' experience building Detroit RotoGrate Stokers. Our Engineering Department at your service—no obligation. Write for Bulletin.

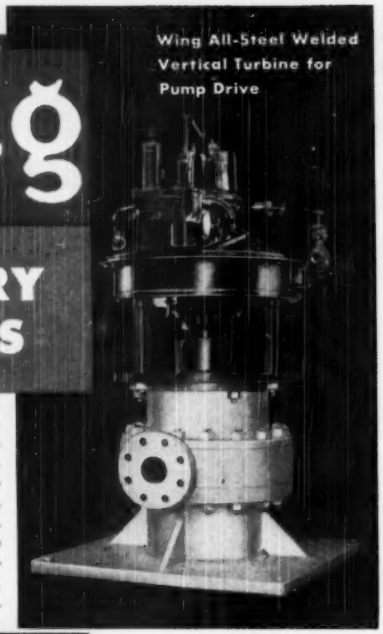
Recent Orders:

American Box Board Co.
Grand Rapids, Mich. (Two Contracts)
Appleton Coated Paper Co.
Appleton, Wisconsin
Chillicothe Paper Co.
Chillicothe, Ohio
Consolidated Paper Co.
Monroe, Michigan (Two Contracts)
Flambeau Paper Company
Park Falls, Wis.
Fletcher Paper Company
Alpena, Michigan
The Great Northern Paper Co.
Millinocket, Maine
Hoberg Paper Mills, Inc.
Green Bay, Wisconsin
International Paper Co.
Panama City, Fla.
Manitoba Paper Co. Ltd.
Pine Falls, Manitoba
Michigan Carton Company
Battle Creek, Mich.
Michigan Paper Company
Plainwell, Michigan
Northwest Paper Company
Cloquet, Minnesota (Two Contracts)
Rex Paper Company
Kalamazoo, Michigan
River Raisin Paper Co.
Monroe, Michigan
Schmidt & Ault Paper Co.
York, Pennsylvania
Sutherland Paper Company
Kalamazoo, Michigan
Thilmany Pulp & Paper Co.
Kaukauna, Wisconsin
West Virginia Pulp & Paper Co.
(Two Contracts)
Charleston, S. C. and Covington, Va.

DETROIT STOKER COMPANY
GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN
WORKS AT MONROE, MICHIGAN • DISTRICT OFFICES IN PRINCIPAL CITIES

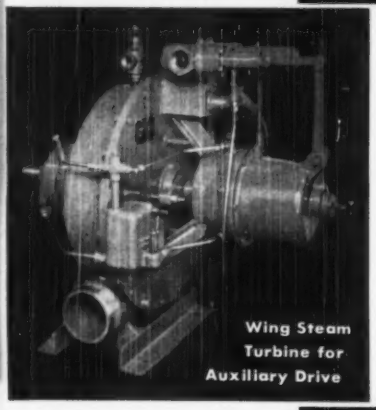
Wing

AUXILIARY TURBINES



Wing All-Steel Welded Vertical Turbine for Pump Drive

Rugged, compact, and dependable Wing Auxiliary Turbines are the most adequate and economical means of supplying power for many industrial and marine requirements. Their many advantages include low operating cost . . . elimination of electric power . . . lower maintenance costs . . . and the fact that the oil-free exhaust stream resulting from their operation may be used for other purposes, such as heating, process work, etc.



Wing Steam Turbine for Auxiliary Drive

In over fifty years of service Wing Auxiliary Turbines have amply proved their ability to stand up under the most rigorous service as prime movers for mixers, marine gear, pumps, fans, winches, generators, compressors, and other equipment. Their long record of consistently trouble-free performance has resulted in increasing acceptance of Wing Auxiliary Turbines as a source of power in many applications formerly using motor drive.

For further information on Wing Auxiliary Turbines write for Bulletin SW-48

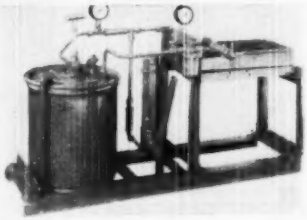
L. J. Wing Mfg. Co.
50 Seventh Ave.
New York 11, N. Y.
Factories:
Newark, N. J. • Montreal, Can.

Wing Turbine and Gear Combination on common pedestal base

ical-delivery plunger *B*. A pressure takeoff, from each end of the reciprocating pump's fluid cylinder, connects into opposite ends of the chemical pump's drive cylinder at *C* and *D*. Pressure surges of the main pump are thus transmitted to the chemical pump's piston, causing it to reciprocate in step with the driving unit. Any changes in pumping rate of the main pump also changes the pumping rate of the chemical pump.

A screw *S* in the cylinder head permits adjustment of the stroke to vary chemical feed at will. Chemical suction and discharge valves are heavy plug type, with rifled ports to cause the valves to swirl for self-cleaning of their seats, walls and wings.

Nelson Pumps, Wright Chemical Corp, 627 West Lake St, Chicago 6, Ill.

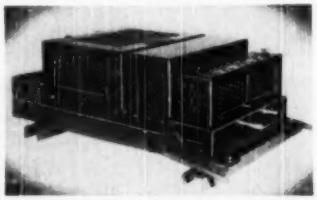


TEST FIXTURE **P226**

Hydraulic-test unit mounts on bench for checking hose assemblies, piping, tubing, gages and valves.

Equipment consists of low-pressure pump for filling equipment and a high-pressure pump, good up to 5000 psi, and a 3-gal reservoir. Higher-pressure units are available.

J N Fauver Co, Inc, 49 West Hancock, Detroit, Mich.



DC TO AC CONVERTER **P258**

These vibrator converters are available in models for operation on 32-, 64- and 120-v dc input. All units have an output rating of 115-v dc, 60 cycles, 375 volt-amperes. Over-all size of the converters mounted on racks is 26½x18x10-in.

Unit boasts of no service interruptions. Standby vibrator automatically picks up load at end of service vibrator life. Service vibrator can be replaced at main repair depot.

Cornell-Dubilier Electric Corp, 2900 Columbia Ave, Indianapolis, Ind.

SOLDERING GUN **P244**

High-speed, single-pole electrode soldering gun, *Cal-88*, enables workmen to get into narrow spaces between relay and electronic circuit parts.

(*Continued on page* 202)

PLANT EQUIPMENT NEWS

Reader Service Page for New Products and Literature

Use the handy FREE service cards for additional information on this month's new products or for copies of latest trade catalogs.

AIR CONDITIONING, HEATING, REFRIGERATION AND VENTILATION

A17 **MECHANICAL DRAFT FANS**—Green Fuel Economizer Co, Bencon, N. Y. 20-page bulletin No. 166 contains descriptive data on the company's line of mechanical draft fans built in both single and double inlet designs, with or without inlet boxes as required. Illustrations and diagrams are included.

A18 **FAN STANDARDS** — National Assn of Fan Manufacturers Inc, 2159 Guardian Bldg, Detroit 26, Mich. 3-page form No. 109 sets forth recommended standard sizes for vaneaxial and tubeaxial fans.

BOILERS AND AUXILIARIES

B21 **PACKAGE STEAM GENERATORS** — Foster Wheeler Corp, 165 Broadway, New York 6, N. Y. 12-page booklet No. PG-49-13 features a series of Foster Wheeler coal-oil-gas package steam generators. Capacity and dimension tables for each design pressure, performance curves and cross-sectional views are given.

B22 **HEATING UNITS**—Black, Sivalls & Bryson Inc, 720 Delaware, Kansas City 6, Mo. 8-page folder describes a new heating unit that can be used interchangeably as a steam boiler or hot water heater by adapting the control equipment accordingly. Designed primarily for smaller industrial requirements, charts give capacities and specifications for the unit both as a boiler and as a heater.

B23 **STEAM BOILER UNIT**—Johnston Brothers Inc, Ferrysburg, Mich. 4-page brochure No. 505 tells about Johnston steam boiler unit, a self-contained, compact, completely equipped steam generating plant. Specification and dimension table is included.

B24 **BOILER-STOKER COMBINATION**—Brownell Co, Dayton 1, Ohio. 8-page bulletin No. BF-1 describes Brownell Unitbilt Combination, a high-leg direct draft boiler with built-in wormfeed stoker. Parts are illustrated and explained, dimensions and details listed.

B25 **SCOTCH BOILERS** — Johnston Brothers Inc, Ferrysburg, Mich. 4-page leaflet No. 9000 features low pressure heating all-welded scotch boilers for oil, gas or stoker firing.

B26 **LABORATORY CRUSHERS** — American Pulverizer Co, 1249 Macklind Ave, St. Louis 10, Mo. 6-page broadside, entitled "For Better Testing and Small Scale Reduction," discusses practical applications of American laboratory crushers, grinders and shredders in testing laboratories and universities for reduction of coal, by-products, chemicals, clays and other products.

B27 **STEAM GENERATORS** — C H Dutton Co, Kalamazoo, Mich. 4-page folder features Dutton line of horizontal return and vertical boilers with choice of oil, gas, hand or stoker firing. Illustrations and descriptions of each are included.

ELECTRIC EQUIPMENT

F45 **POWER TRANSFORMER** — Westinghouse Electric Corp, P O Box 2099, Pittsburgh 30, Pa. 24-page booklet No. B-4142 contains information on the design of modern Westinghouse power transformers. Con-

HOW TO ORDER ADDITIONAL DATA

Be sure to fill out, completely, one coupon for each item of information you order. (See sample, right.) This gives your request authority and helps the manufacturer to address your copy completely.

When you have filled out completely one space for each item of information you want, detach along the scored lines and drop the cards in the mail.

Example

Write here number of item in which you are interested → E17

Your Company Name Brown Mfg Co.

Address 3718 First Avenue Pottsville, Okla.

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Your Title Power Engineer

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struction details of shell-form and core-form oil- and air-insulated power transformers are described and illustrated.

F46 **DRY-TYPE TRANSFORMERS**—Allis-Chalmers Mfg Co, 951 S 70th St, Milwaukee, Wis. 8-page folder No. 61B6382A describes versatile and flexible Allis-Chalmers dry-type transformers built in sizes of 1½ kva and larger, single-phase, and 9 kva and larger, three-phase, suitable for duty right at the load center.

F47 **COLD CATHODE FLUORESCENT LIGHTING** — Fluorescent Lighting Assn, 501 Fifth Ave, New York 17, N. Y. 8-page publication furnishes descriptive data and technical information on the use of standard and custom cold cathode lamps. Included are sections on installation of cold cathode and charts giving photo-metric data of standard lamps.

F48 **CIRCUIT RECLOSER**—Westinghouse Electric Corp, P O Box 2099, Pittsburgh 30, Pa. 4-page bulletin No. B-4339 explains operation of the new Westinghouse 100-ampere type GR recloser. Diagrams and semi-pictorial drawings help in visualising operation step by step.

F49 **TERMINALS**—Flexilab Products Co, 4945 Colorado Blvd, Denver 16, Colo. Single-sheet broadside No. C-1 features Flexilab electrical terminals and adapters. Construction and design, as well as a few of the many connections possible, of these terminals and adapters are illustrated.

F50 **INSTRUMENT TRANSFORMERS** —Westinghouse Electric Corp, P O Box 2099, Pittsburgh 30, Pa. 12-page catalog No. B-4319 points out construction features of complete Westinghouse line of instrument transformers.

HEAT EXCHANGERS

G1 **AIR COOLERS** — American Locomotive Co, Alco Products Div, Dunkirk, N. Y. 20-page booklet, entitled "Alco Aircoolers," gives informative data on principles of air cooling, and relates basic mechanical facts of radiator core and fintube models of Alco Aircoolers.

G2 **OIL PREHEATER**—Boyar Products Corp, Lombard, Ill. 8-page folder, entitled "Pre-Heat" shows horizontal and vertical electric fuel-oil types of Boyar preheaters. Rating and viscosity temperature charts are given.

MAINTENANCE AND SAFETY EQUIPMENT

K13 **PIPE TOOLS CATALOG**—Beaver Pipe Tools Inc, Dana Ave, Warren, Ohio. Bulletin No. 50 is a revised Beaver Pipe Tools catalog which carries complete up-to-date information on the company's line of pipe tools, machines, power drives and threading oil.

K14 **OIL CUP AND GAGE** — Trico Fuse Mfg Co, 2948 N 5th St, Milwaukee 12, Wis. Single-sheet form No. 31 tells about a combination visible oil cup and oil gage—both in one unit. Approximate dimensions in inches and list prices are given.

K15 **EQUIPMENT CATALOG** — Martindale Electric Co, 1325 Hird Ave, Cleveland 7, Ohio. 64-page catalog No. 28 is replete with illustrations, specifications and prices for commutator, motor, electrical and mechanical maintenance equipment, and production and safety equipment.

K16 **POWER PIPE THREADER** — Beaver Pipe Tools Inc, Dana Ave, Warren, Ohio. 4-page folder discusses the Model-C portable power pipe threader. Bulletin is filled with useful information contributed by users of the machine, who tell where and how they used it and what effect the unit had on their operations.

K17 **LUBRICATING DEVICES**—Trico Fuse Mfg Co, 2948 N 5th St, Milwaukee 12, Wis. 4-page broadside No. 4800-OB describes and pictures the Trico line of lubricating devices consisting of constant level, gravity-feed, wick feed, thermal, bottle, "Micro-Matic," "Vari-Feed," and underfeed oilers; combination oil cups and oil gages.

MAINTENANCE MATERIALS

L33 **CONCRETE FLOORS** — Master Builders Co, Cleveland 3, Ohio. 36-page booklet, entitled "The Masterplate Iron-Clad Concrete Floor," gives full information on the product and its advantages. Job pictures are shown and detailed illustrated directions for laying a Masterplate floor are given.

L34 **TOOL WORKING MANUAL** — Allegheny Ludlum Steel Corp, Henry W Oliver Bldg, Pittsburgh 22, Pa. 16-page data book, entitled "The Working of Tool and High Speed Steels," contains specific information summarized from laboratory and service tests on various grades in the A-L line. A simple selector chart, procedures and tabulations form a working manual for makers and users of cutting tools and dies.

L35 **LOCK WASHER SCREWS** — Pheoll Mfg Co, 5700 Roosevelt Rd, Chicago 50, Ill. 28-page bulletin No. 30-A describes "Sems" (lock washer screws) as an assembled screw and free-rotating washer.

MATERIALS HANDLING

M26 **MATERIALS HANDLING MANUAL**—Aerol Co Inc, 2820 Ontario St, Burbank, Calif. Catalog has complete illustrations of all Aerol products and drawings which show exactly how they solve particular materials handling problems. Dimensions, load ratings, and code numbers are tabulated for quick and easy reference.

All literature designated with a star (★) may be obtained only by writing direct to the manufacturer on company letterhead, giving writer's name and title.

★ **FREIGHT ELEVATOR** — Westinghouse Electric Corp, Elevator Div, Jersey City, N. J. 4-page buyer's guide booklet contains ten profusely illustrated sections that explain the basic considerations involved when selecting freight elevators and gives component parts of same.

METALS AND ALLOYS

R13 **BEARINGS AND CASTINGS** — National Bearing Div, American Brake Shoe Co, 4320 Manchester Ave, St. Louis 10, Mo. 28-page bulletin, entitled "Bronze and Copper Bearings and Castings," gives physical properties and

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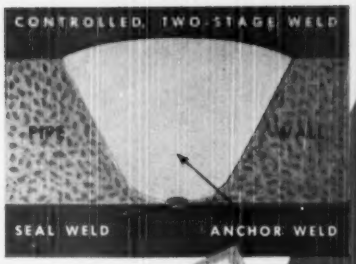

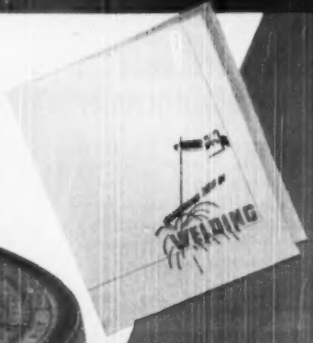

OVERWHELMED and PERPLEXED!

THERE'S NO NEED TO BE WITH YOUR PIPING PROBLEMS

This child is obviously "overwhelmed and perplexed" with the size and complexities of the earth. But naturally, she's not expected to know what it's all about, much like any power plant maintenance engineer who is too busy to be expected to know all the intricacies of pipe engineering or to have time to develop adequate facilities to do a thorough job. That's where we come in. Our 50 years in the prefabricated piping business, solving ever-changing piping needs (high temperatures, high pressures) of progressing industry, has endowed us with the "know how" of pipe engineering and erection. And, too, we have developed a well coordinated team and shop facilities equipped to handle large or small jobs and relieve you of all piping details. If you are "overwhelmed and perplexed" with piping problems because of lack of time and proper facilities, call us. Also ask us about the Mitchell-Westport Joint which prevents metal protrusions inside the pipe without using backing rings. It's described in our bulletin, "Something New in Welding." Write for it now.

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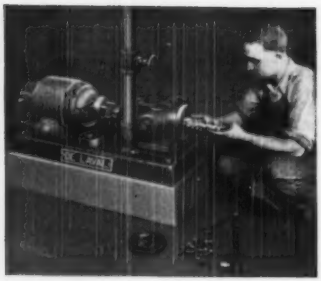

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IMO Pumps are designed for handling oils, hydraulic control fluids and other liquids over a wide viscosity range.

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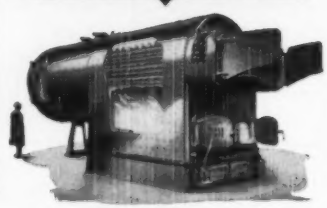

10 to 304 hp
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Has all the characteristics which make firebox boilers ideal for high pressure. Complies fully with ASME and SBI codes.

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comparative specifications for 27 different bronze alloys and 5 aluminum and manganese bronzes.

R14 **STEEL CASTINGS CHART** — Steel Founders' Society of America, 920 Midland Bldg, Cleveland 15, Ohio. 4-page folder consists of factual engineering data emphasizing versatility, strength and dependability of steel castings, incorporated in a comprehensive technical chart as an aid to design engineers and purchasing department engineering staffs.

PRIME MOVERS AND ACCESSORIES

V11 **STANDARDIZED DIESEL ENGINES** — American Locomotive Co. Stationary & Marine Diesel Engine Div. Auburn, N. Y. 8-page bulletin, entitled "Alco Standardized Diesel Engine," illustrates construction of these standardized engines. Specifications and a list of features are included.

V12 **DIESEL ENGINES** — Superior Engine Div, National Supply Co, Springfield, Ohio. 20-page booklet No. 4812 describes Superior diesel engines for stationary installations. Included are more than 100 specifications showing a range in power from the naturally aspirated, 6-cylinder, 175-hp engine with 8¼ x 10½-in. bore and stroke, to a supercharged, 8-cylinder, 1500-hp engine with 14½ x 20-in. bore and stroke.

PUMPS

W22 **ROTARY PUMPS** — De Laval Steam Turbine Co, Trenton 2, N. J. 4-page catalog No. LG shows cutaway drawings of the six different types of De Laval-IMO rotary pumps, along with brief description of each. Capacities range from 0.5 to 1000 gpm for pressures to 500 psi, to 150 gpm for pressures to 1500 psi.

W23 **CENTRIFUGAL CHEMICAL PUMPS**—Worthington Pump & Machinery Corp, Harrison, N. J. 12-page publication No. W-350-B11 presents some of Worthington's centrifugal pumping equipment used in the chemical process industries. Complete explanation of Worthington Mechanical Seal specially designed to prevent leakage of corrosive liquids, and a description of Worthite, a corrosion resistant metal, are given.

W24 **GAS PUMPS** — Roots-Connersville Blower Corp, Connersville, Ind. 8-page bulletin No. 51-B-17 covers the company's Type XA gas pumps which are used as boosters or exhausters in a wide range of industrial and other applications. Sectional views are included.

W25 **CENTRIFUGAL FIRE PUMPS** —Peerless Pump Div, Food Machinery & Chemical Corp, 301 West Ave 26, Los Angeles 31, Calif. 24-page catalog No. B-1500 gives informative data on both single- and two-stage centrifugal fire pumps and their methods of drive and application.

W26 **SELF-PRIMING CENTRIFUGAL PUMP**—La Bour Co Inc, Elkhart, Ind. 16-page booklet No. 53 discusses La Bour Type G vertical, self-priming centrifugal pump. Operating information and instruction for installation and care of these pumps is included.

W27 **PUMP CONTROL** — Cutler-Hammer Inc, 294 N 12th St, Milwaukee 1, Wis. Bulletin No. 9589D-21 describes Cutler-Hammer oil well pumping control, designed for across-the-line starting of squirrel cage motors.

OTHER EQUIPMENT

Z31 **DUPLEX COMPRESSORS** — Pennsylvania Pump & Compressor Co, Easton, Pa. 24-page catalog No. 203 tells about Pennsylvania horizontal duplex heavy duty compressors. Complete coverage is also given to the firm's air cushion valve.

Z32 **VOLTAGE REGULATORS** — Sorenson & Co Inc, 375 Fairfield Ave, Stamford, Conn. Two booklets

you save steam when your condensers are Oakite-clean!

WHEN condenser tubes are scale-fouled, a lot of BTU's go up the stack. So if limescale is reducing the efficiency of your condenser performance, switch to low-cost Oakite cleaning and descaling to eliminate serious heat-transfer difficulties. That way you get maximum value out of every fuel dollar.

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To handle the job efficiently, economically, there are scientifically designed Oakite alkaline materials for fast, easy cleaning of the steam-side of your condensers. For descaling the water-side surfaces, there are safe, thorough acidic Oakite descalants.

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You can get the facts about these effective Oakite compounds and full step-by-step details by contacting your nearby Oakite Technical Service Representative. Or send today for your free copy of the illustrated "Oakite 71 Digest" — and read the Oakite story of condenser-cleaning. Write to

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D-C Power Costs Cut 20% Yearly!

Mr. R. H. Hill, chief electrical engineer at U. S. Arsenal, Watervliet, N. Y., makes a periodical inspection of G-E mercury-arc rectifier.

G-E rectifiers cut Arsenal's yearly maintenance and operating costs $3500

Mr. R. H. Hill, at the U. S. Government Arsenal, Watervliet, N. Y. is just one of the many forward-looking plant engineers who is cutting his plant's power bill with the new, modern way to get d-c power—by installing mercury-arc power rectifiers.

You can install these units, and then practically forget them. This means big savings in both maintenance and operating costs.

Mr. Hill, for example, says that installing a G-E 400-kw rectifier at the arsenal in 1943 reduced maintenance expense $500 a year. At the same time he reduced operating expense about $3000 a year, because he was able to transfer to other work the operators formerly needed. Total savings of $3500 represent a 20% cut in yearly d-c power costs.

TO CUT YOUR POWER COSTS

Find out today how you can cut your power bills by putting G-E mercury-arc power rectifiers to work in your plant. Call or write your nearest G-E sales office for information. *Apparatus Department, General Electric Company, Schenectady, N. Y.*

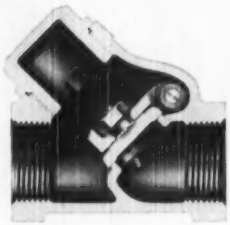
G-E Mercury-arc Rectifiers Mean Low-cost D-c Power

GENERAL ELECTRIC

When a valve must make its own decisions use KENNEDY Swing Check Valves

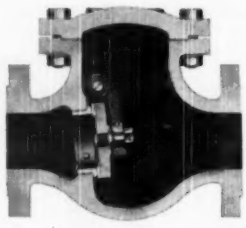
A swing check valve often guards the most vital point in your lines. That is why you will want the full assurance of KENNEDY'S seventy-three years of valve experience back of the check valves you select. When things are flowing smoothly . . . in the right direction . . . it stays open with minimum flow resistance. The moment back pressure develops it closes instantly and positively!

KENNEDY manufactures check valves in a wide range of types and sizes. Write for full details.



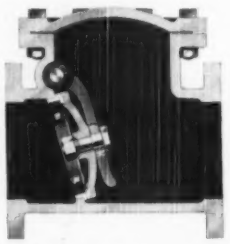
KENNEDY FIG. 492—BRONZE SWING CHECK VALVE

Steam 300 lbs. at 550° F. Cold Water, Oil or Gas, Non-shock, 600 lbs. Generous diameter cap permits easy inspection and regrinding without removing from line. Swing disc swivels in hinge while a stop on the cap prevents sticking in open position. Sizes ½" to 3".



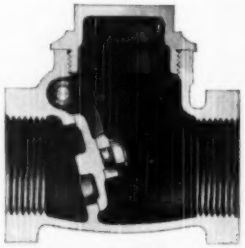
KENNEDY FIG. 889—IRON BODY BRONZE MOUNTED

Bronze Faced Disc. Steam 250 lbs. at 500° F. Cold Water, Oil or Gas, Non-shock, 500 lbs. Revolving disc is self-adjusting. Angular placement permits easy opening at low pressures while also reducing closing shock at high back pressures. Sizes 2" to 10".



KENNEDY FIG. 106—IRON-BODY SWING CHECK VALVE

Flanged; Bronze Mounted, Bronze Faced Disc. 2" to 12" Saturated Steam 125 lbs. Cold Water, Oil or Gas, Non-shock, 175 lbs. Has revolving, self-adjusting disc angled for easy opening at low pressure and shock reducing closing at high back pressure. Sizes 2" to 24".



KENNEDY FIG. 103—BRONZE SWING CHECK VALVE

Bronze or Leather-Faced Disc. Saturated steam 125 lbs. Cold Water, Non-shock, 200 lbs. Also recommended for use on oil and gas lines. Leather-Faced disc should be used on cold water lines. Easy swinging disc is hinged on bronze pin . . . will not stick in open position. Sizes ½" to 4".

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VALVES • PIPE FITTINGS • FIRE HYDRANTS

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cover new line of Sorenson electronic voltage regulators. Catalog No. A-1049 contains specifications and description of the standard ones for control of ac power. Catalog No. B-1049 lists and describes the line of dc power sources and supplies.

Z33 **TEMPERATURE REGULATORS** —Spence Engrg Co Inc, Walden, N. Y. 6-page pamphlet outlines construction and operation of Spence Type E2T100 temperature regulator, an external pilot, self-operated regulator.

Z34 **FINISHING CEMENT**—Baldwin-Hill Co, Trenton 2, N. J. 4-page broadside points out advantages and characteristics of Powerhouse cement, a finishing cement that insulates.

Z35 **SILENT CHAIN DRIVE**—Whitney Chain & Mfg Co, Hartford 2, Conn. Catalog on silent chain drive makes selection of silent chain and chain drives easy by using Whitney tables listed in it.

Z36 **MEGOHMMETER** — Herman H Stitch Co Inc, 27 Park Place, New York, N. Y. 4-page bulletin No. 1029 features Model 29 Twenty Million megohmmeter giving general description, principle of operation, and specification.

Z37 **LIQUID LEVEL METERS** — Fischer & Porter Co, 75 County Line Rd, Hatboro, Pa. 24-page booklet No. 75 describes the company's line of Levelimeter instruments for indicating, measuring, and controlling liquid level and inter-face level.

Z38 **QUICK-OPERATING VALVE** — Everlasting Valve Co, 49 Fisk St, Jersey City 5, N. J. 14-page catalog No. E-160 explains application of Everlasting quick-operating valves to blow-off service and on fire protection, chemical process, soot blower, water column blow-down, and other types of pipe lines.

Z39 **TESTING PROCEDURES** — Owens-Corning Fiberglas Corp, 16 E 56th St, New York 22, N. Y. 36-page publication, entitled "Testing Methods and Facilities Used on Fiberglas Products," tells about facilities and procedures employed by the company in its testing laboratories.

Z40 **TECHNICAL DATA** — Lefax, Philadelphia 7, Pa. Catalog furnishes complete information and list of 2000 subject titles on essential data for engineers and students, which has been prepared in pocket sized binders.

Dr Charles M Slack has been named technical director of Westinghouse Electric Corporation's Atomic Power Div. In his new position he will have staff responsibility for the general direction and coordination of all research and engineering work of the div. The first major project is the building of an atomic power plant for Naval ship propulsion in cooperation with Argonne National Laboratory, of Chicago, under contract awarded by the Atomic Energy Commission.

Pacific Gas and Electric Co and the Fresno Irrigation District will develop power at Kings River, Calif., according to the announcement of the Federal Power Commission. The license permits installation of a total of 274,000 kw. The Fresno Irrigation District had proposed 144,000 kw, and the Bureau of Reclamation only 101,500 kw.

Chain Belt Co, of Milwaukee, announces opening of a new modern warehouse in conjunction with new expanded facilities for the Dallas district sales office at 1611 Dragon St, Dallas, Texas.

IN WATER CONDITIONING

It's Like Finding Money when you...

use Amberlite IR-120

CHECK THESE ADVANTAGES

AMBERLITE IR-120 is a high capacity synthetic resin cation exchanger produced in the form of attrition-resistant, bead-like particles. AMBERLITE IR-120 is:

- —stable over the entire pH range
- —unaffected by hot solutions; can be operated at temperatures close to boiling
- —insoluble in all common solvents
- —unaffected by low-silica waters
- —resistant to strong oxidizing and reducing media
- —uniform in particle size
- —extremely high in regeneration efficiency
- —extremely high in capacity even at high flow rates
- —*lower in operating cost!*

And it's like throwing money away when you install low-capacity, physically and chemically unstable cation exchangers in your water softening or deionizing units.

Where does the money go? Into the chemicals used for too frequent regeneration of low capacity exchangers . . . into replacement of unstable exchanger that has dissolved in low-silica waters, that has been worn by constant attrition, that has succumbed to hot water, to strong oxidizing and reducing media, to acids and alkalies. It goes into the scores of restrictions and precautions, the delays and recalculations that are part of exchangers whose capacity varies with changes in flow rates, in magnesium content of the water—even with the Seasons!

Where is the money to be found? In the use of AMBERLITE IR-120—stable, high capacity synthetic resin exchanger now available in large quantities. Check the advantages listed at the left. Then write to Department POW-1 for technical literature that describes the resin in greater detail.

AMBERLITE is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries.

SAVE PROCESS STEPS

WITH THE AMBERLITES

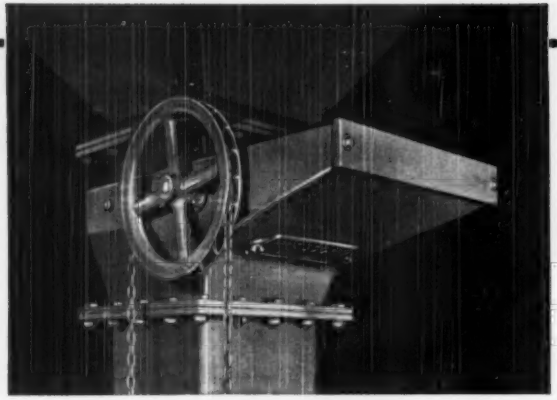
CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square Philadelphia 5, Pa.

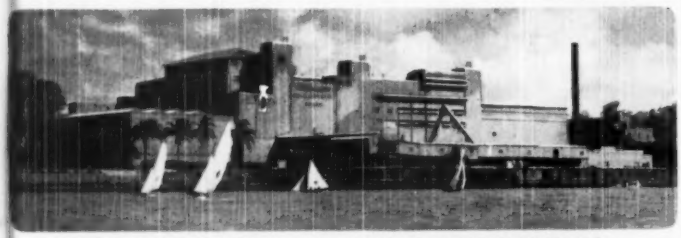
The Resinous Products Division was formerly The Resinous Products & Chemical Company



S-E-CO. COAL VALVES will not stick in operation because the S-E-Co. U-shaped gate, together with the double rack and pinion and roller bearing rollers, allows the valve to operate easily regardless of the corrosive and dusty condition that exists within the body of the valve. For a coal valve that will open and shut when required, use a S-E-Co. Valve.

Bulletin upon request.

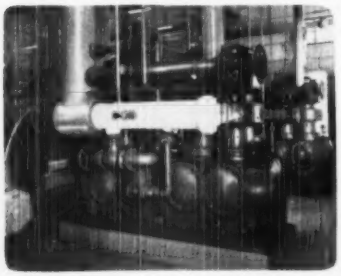
STOCK ENGINEERING COMPANY
715P Hanna Building ★ Cleveland 15, Ohio



BIG AUSTRALIAN PACKING PLANT INSTALLS

Frick Refrigeration

The Queensland Meat Industry Board recently installed three Frick ammonia booster compressors for producing low temperatures at the Brisbane Abattoir. The Board says these big machines, each with four cylinders of 15" bore and 10" stroke, "have worked very efficiently," and have increased the output of the freezers at Brisbane by 26%.



Two of Three Frick Compressors at Brisbane

Annual capacity of the plant now approximates 250,000 cattle, 150,000 calves, 50,000 hogs, and 700,000 sheep and lambs.

Whether you're in Augusta or Australia, if you need air conditioning, refrigerating or ice-making equipment in commercial or industrial sizes, there's a Frick system to meet your requirements. Ask for recommendations and estimates.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA. U.S.A.

Also Builders of Power Farming and Sawmill Machinery

POWER NEWS

(Continued from page 140)

forcement of air-pollution laws because of the damage to public health and property by stack emissions. A light, compact, reliable smoke indicator, not now available, would be of great help in the enforcement of smoke-abatement laws, said the speaker.

At the afternoon session, John Doyle vice-president, Thermix Corp, talked on "Stack Emissions, Their Problems and Means of Improvement." After giving a comprehensive presentation of these problems, he said the problems of stack emissions are great. In addition to boiler stacks there are kilns, blast furnaces, open hearths, smelters, electric furnaces, chemical exhausts, locomotives and many others that require elimination equipment of one type or another.

Some of these problems we can solve now. Others require extensive research and development to find a proper answer. If public officials, industry and manufacturers of eliminating equipment work together, our cities and towns will be cleaner and healthier places to live in.

Robert H Saunders, chairman, Hydro-Electric Power Commission of Ontario, guest speaker at the power-show luncheon, told how the commission's power system had grown into one that generates and distributes over 13-billion kwhr annually and has a peak load of over two million kw. To meet growing power load demands the commission has 1,044,000 kw under construction for completion by 1952.

At a round-table forum, the speakers were James A Kearns, consulting engineer; N McMurrich, architect; and R G Edwards, industrial power engineer. From this presentation it was evident that much could be accomplished in plant design and construction by closer cooperation between plant management, architects, consulting engineers, operating engineers and general contractors.

"Fuel Selection" was the subject of a comprehensive paper by Thomas P Bateman, western service engineer, Pittsburgh Consolidated Coal Co. Fuel selection, he said, is a separate problem in each plant and must be treated as such, but there are four basic fuel requirements common to all. These are ability to (1) meet load demands (2) give maximum economy (3) cause minimum nuisance, for instance with smoke and dust (4) provide a continuous and reliable supply.

Other papers presented were "Stokers" by William Bardsley; "Technical Training of Student Engineers" by James Gillespie; "Electricity" by Allen Frizzell—all of the Toronto Central Technical School; and "Refrigera-

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Powdered formulations for inhibiting corrosion in brine and circulating water systems and low pressure boiler plants.

☐ **No. 160 Series**

A liquid formulation of the volatile amines for corrosion control in condensate return systems.

☐ **A-C Anti-Foam**

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Carl H. Grinnell, with 25 years experience in power plant water conditioning, is one of the Allis-Chalmers specialists located around the country to advise you on correct water conditioning equipment, chemicals and service. For free survey, call your nearby Allis-Chalmers office!

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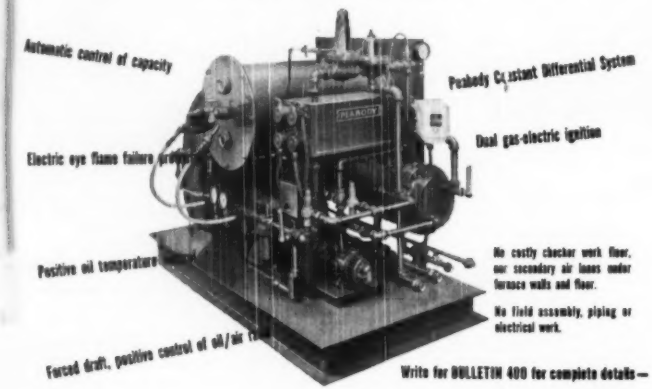
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OFFICES IN PRINCIPAL CITIES

107

tion" by Mark Johnson, Canadian General Electric Co.

Officers elected for 1950 are: *president*, J C Buchanan, chief instructor, power engineering school, Ryerson Institute, Toronto, Ont.; *1st vice-president*, J F Humphreys, power engineer, Polymer Corp, Sarnia, Ont.; *2nd vice-president*, Allen Hutchison, mechanical superintendent, Ogilvys Department Stores, Montreal; *general secretary*, W G Childs, chief engineer, Gair Company of Canada, Toronto, Ont.

Next convention will be held in Montreal, tentative date for which is Oct 19, 20 and 21, 1950.

John S Cotton, consulting engineer of San Anselmo, Calif., has been engaged by State of Israel to prepare a master plan and designs for irrigation and power development of Israel. This involves conducting waters of the Jordan River, for generation of power, from the northern boundary to southern end of the country for irrigation, and conducting Mediterranean sea water to the Dead Sea, which is about 400 meters lower than the Mediterranean. The sea water, after generating power, will be evaporated.

In a further effort to cooperate with the smoke-control program, the railroads serving Allegheny County, Pa., and the bituminous coal industry have launched a research and development project aimed at reducing that part of air pollution resulting from flyash and cinders emitted by steam locomotives. A special committee, to be known as the Locomotive Cinder Collector Research and Development Committee, has been formed to supervise the jointly financed program of the railroads and representative of Bituminous Coal Research, Inc., the national research agency of the bituminous coal industry. This 11-man committee will direct the work that will include the design, construction and testing of a cinder and flyash collection and disposal system suitable for conventional steam locomotives.

American Society of Mechanical Engineers has published the 1950 edition of Section Eight of the *Boiler Construction Code* for unfired pressure vessels. This edition embodies all revisions since the 1946 edition. It covers carbon and low-alloy steels only. Stress tables are based on a factor of safety of four rather than five. Copies are available from the society at 29 West 39th St, New York, N.Y. for $3.50 each.

Aluminum Co of America's new Pittsburgh skyscraper will have eight elevators capable of a speed of 1000 ft per min, and six with a speed of 800 ft per min. Westinghouse Elevator Div will install the equipment and all necessary signal controls.

Tennessee Valley Authority awarded a $700,000 contract to Worthington Pump & Mach Corp for nine motor-driven centrifugal boiler feed pumps, serving three 1,000,000-lb-per-hr boilers in the Johnsville steam plant.

Exide Men began where you left off, Mr. Diesel

No one knew better than you, Mr. Diesel, that when you gave your engine to the world it was but a beginning.

You must have foreseen that cranking would become increasingly difficult as more powerful engines were developed and their applications multiplied.

But those future cranking problems were for others to solve. Where you left off, Exide carried on.

For many years Exide Men have worked closely with engine and starter manufacturers. Battery after battery has been designed and redesigned. Tests have followed tests . . . in laboratory and in service . . . under all operating conditions.

Today, builders and users of Diesel engines enjoy the benefits of those years of unceasing effort. For Exide provides batteries that are equal to any service demand.

When your Diesel cranking batteries are Exides, you can count on a quick breakaway and a high cranking speed.

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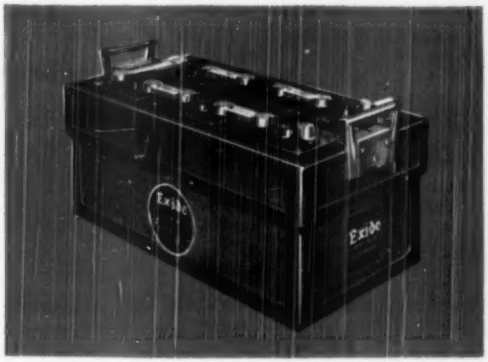

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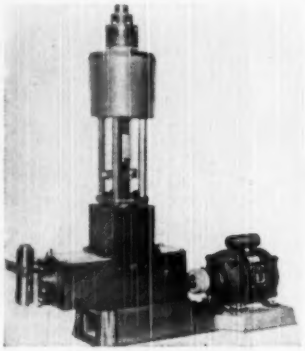
NEW EQUIPMENT BRIEFS

(*Continued from page 192*)

A full-view light shines on top of the electrode and the parts being soldered. Entire gun weighs only 1½ lb. It has a pistol-grip with a full 3-finger trigger that controls a dual-heat setup. Top of the trip enables the gun to put out 150 watts, and the bottom 100 watts. Unit operates on 60-cycle 110-v ac.

Calire Mfg Co, Inc, 45 Washington St, West Orange, N. J.

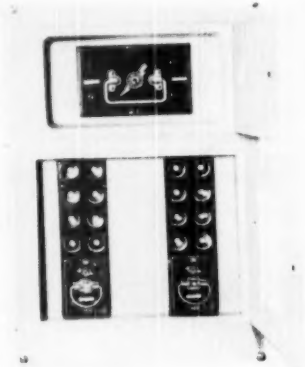


CHEMICAL-FEEDER P227

Auto-Pneu-Matic unit provides automatic instrument control for the *Pulsafeeder* output.

Pulsafeeder is designed so output can be adjusted during operation and, with the *Auto-Pneu-Matic* controller, volume can be changed from zero to full displacement automatically. Device is also suitable for use with all commercial pneumatic systems, and can be made responsive to any measurable variable such as flow, pH, temperature, liquid level, pressure, etc.

Lapp Insulator Co, Inc, Process Equipment Div, LeRoy, N. Y.



SERVICE SWITCH P265

This 100-amp pullout switch was designed for use as an over-all main disconnect switch. It is available singly or in com-

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3. This books covers the construction, application, operation, installation and maintenance of pumps. Major sections deal with centrifugal, vertical, turbine, regenerative, rotary and reciprocating pumps. Descriptions of each type of pump and its parts, materials, operating characteristics, etc. are included, and thorough treatment is given pump troubles, symptoms, and causes. **By Carter, Karassik and Wright, Worthington Pump and Mach. Corp., 339 pages, $5.00**

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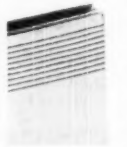

4. A comprehensive survey of our electric power systems and how they grew—with a look at probable future developments. Deals with hydro- and turbo-electric power . . . techniques for the construction, operation and maintenance of systems . . . public regulation over companies, their rates and their profits . . . the rise of industry organizations, etc. Covers power stations, station generation, transmission, general system techniques, distribution etc. **By The Editorial Staff of ELECTRICAL WORLD. 186 pages, $3.50**

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The Type UV Multistage Turbine is available in from two to ten pressure stages making Multistage steam economy available at moderate initial cost. Horsepower range is from 100 to 4000, steam pressures up to 600# ga., 750° F., condensing or non-condensing. Several governors and accessories adapt UV Turbines to practically any mechanical drive within the capacity range.

Pictured is a 5 Stage UV Turbine developing 325 HP at 6200 RPM operating condensing. Turbine is equipped with variable speed oil relay governor, pressure lubrication and vacuum breaker, and is in use driving a centrifugal compressor for refrigeration.

Contact your Murray representative for prices and engineering information or write for Bulletin T-122.

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bination with up to 20 single plug fuse branch circuits, and either one or two 30- or 60-amp double pole fusible pullout branch switches.

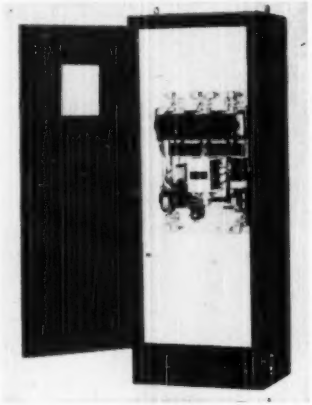
General Switch Corp, 49 Roebling St, Brooklyn 11, N. Y.

MOTOR STARTER **P346**

Designed for controlling polyphase motors, 1 to 100 hp, this combined circuit breaker and starter incorporates several new safety features. Operating handle can be locked in "on" or "off" position with one, two, three or four padlocks of varying sizes. Handle-locking mechanism locks door also.

Circuit breaker is nontemperable, and can be quickly reset. Straight-line, guided vertical motion of armature in magnetic starter and movable-contact assembly eliminates bearing and reduces wear.

Square D Co, Industrial Controller Div, 4041 N Richards St, Milwaukee 12, Wis.



MOTOR STARTER **P250**

Bulletin 709, ac, across-the-line solenoid starter now includes two new larger units. Size 6, rated 600 amp, 200 hp, 220 v; 400 hp, 440-500 v. Size 7 is rated 900 amp, 300 hp, 220 v; 600 hp, 440-550 v.

Both units have one-piece magnetic plunger that operates with vertical straight-line motion. All terminals and wiring accessible from front. There is no back-of-panel wiring.

Allen-Bradley Co, Milwaukee, Wis.

ARC WELDER **P211**

Compact, 2-bearing, 2000-amp Special has been added to this manufacturer's line of arc welders.

Machine combines the 36A generator with a 4-cylinder 31-hp air-cooled Wisconsin engine. Generator has a welding range from 40 amp at 20 v to 250 amp at 40 v. Five-positioned, control wheel mounts on a panel and current readings can be made with a movable pointer. Special is 58½ in. long, 25⅝ in. wide by 47 in. high. It weighs 825 lb.

Air Reduction Co, 60 E 42nd St, New York 17, N. Y.

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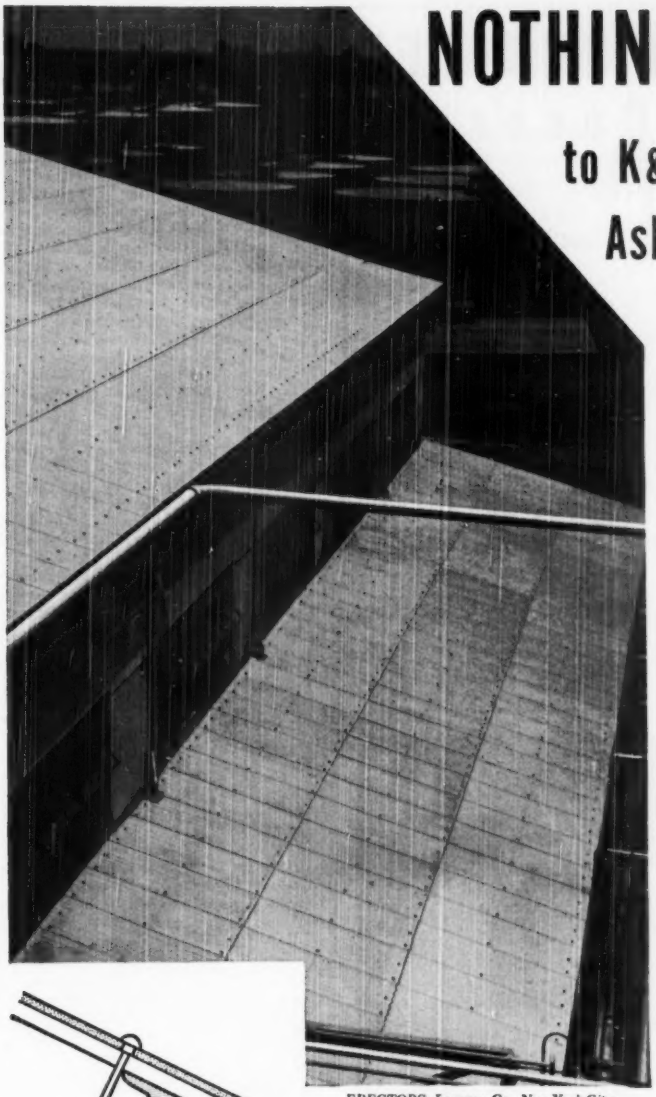


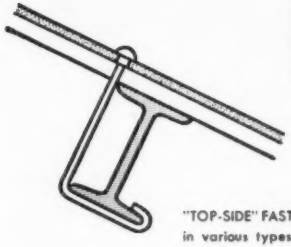
Here you see it used for both the roofing and siding on this Shell Oil Company building at Deer Park, Texas. Don't ever expect to see it hurt by the weather or other adverse atmospheric conditions. Count on it to go rustless and rotless. It won't suffer from rodents and termites, and is exceptionally resistant to fire.

Easily cut and fitted on the job, K&M "Century" Asbestos Corrugated produces tight, good-looking surfaces at minimum labor cost. For extra savings use "TOP-SIDE"* fasteners, as on this Shell building. They entirely eliminate scaffolding and are only available with K&M "Century" Asbestos Corrugated.

Your finished job will benefit by the inherent structural strength of this material which actually gains strength with age. As for upkeep, you needn't figure on even one bit of paint!

*® H. & B. Enterprise Corp.

ERECTORS: Lummus Co., New York City.



"TOP-SIDE" FASTENERS are made in various types, to fit all steel members on both roofing and siding. Illustration of typical "J" type for roofing.

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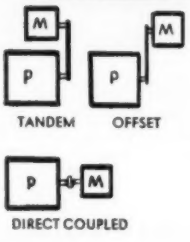
OFFER MOTOR MOUNTINGS TO FIT ANY REQUIREMENTS

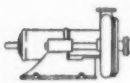
Nagle Pumps Types "T" and "A" are shown with overhead mountings—motors mounted "Piggy Back." Sketches at right show various pump-motor arrangements available to meet varying conditions.

Whatever your space problems are, Nagle Pumps can "fill the bill!"

And, regardless of how corrosive or abrasive the material you handle, Nagle Centrifugal Pumps will handle it with minimum maintenance and maximum economy.

Specific water and materials for each condition, impellers for each loading condition. It pays to consult Nagle Pumps engineers. Send for new Catalog 4906.





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APPOINTMENTS

Combustion Engrg—Superheater, Inc, announces retirement of A V Adamson, manager of New York district office. Adamson continues to serve in capacity of consultant. Other changes are as follows: Arthur Hunter and Robert L Riker are made assistant general sales managers in New York. G P Ellis is manager of Washington, D. C. office and T J McGowan transfers to Philadelphia office. Also, a Western div of the firm is now established in Los Angeles with branch offices in San Francisco and Seattle. Robert M Hatfield Jr is general manager of the division and will be in charge of activities in the states of Washington, Oregon, California, Nevada and Arizona. H G Thielscher is appointed chief engineer with headquarters in San Francisco. In addition, Frank Bader transfers to San Francisco and Elmo Keeler to Los Angeles.

J S Beecher has been made a member of the technical dept of power chemicals div, **E F Drew & Co Inc,** New York City.

Allis-Chalmers reports a change in status of its Grand Rapids, Mich. office from branch to district office. G C Culver continues as district manager. Other changes involve transfer of E J Kelley to Youngstown district office, and T E Marchant to Pittsburgh district office.

S W Rolph has been elected president of **Electric Storage Battery Co,** Philadelphia, succeeding R C Norberg, who has been named chairman, board of directors.

Joy Mfg Co, Pittsburgh, Pa., appoints R G Gehlsen sales manager of its Mines Equipment div. H B Zeppenfeld assumes duties of manager, industrial sales, above div.

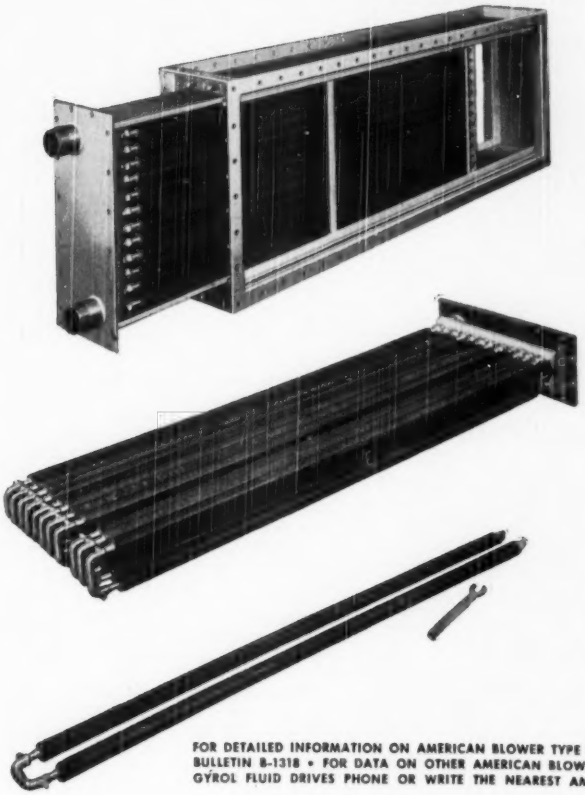
Dr Albert W Hull, of **General Electric** research laboratory, has retired from his post as assistant director. He will continue to serve the laboratory as a consultant.

W B Shirk has been made director of industrial products engineering in the newly formed product development and product engineering section of **Gulf Oil Corp,** Pittsburgh, Pa.

Link-Belt Co announces following changes in plant management personnel: On May 1, Richard E Whinrey will assume duties of assistant general manager at Ewart plant, Indianapolis. Raymond S Wood transfers to Indianapolis to become assistant general manager at Dodge plant, replacing Whinrey. Leslie J Carson becomes general manager of Minneapolis plant and North Central sales div. William P Ridsdale returns to Chicago as chief engineer of Caldwell plant.

Graybar Electric Co's Southwestern district with headquarters at Dallas is divided into two separate units. Offices of the newly created Gulf Coast district are at Houston. Both districts continue to operate under supervision of G T Marchmont, district manager. Branch houses reporting to Houston under new setup are Beaumont and

A.B.C. HEAVY DUTY STEAM COILS



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Entire heating element of American Blower Type H Heavy Duty Coil is removable from casing. Side rails provide sliding surface for easy removal and also protect tubes against damage.

REPLACEABLE CUPRO-NICKEL TUBES

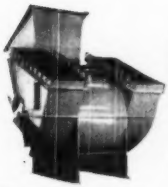
Once removed, the heating element can be completely dismantled for inspection, maintenance or repair. Individual corrosion-resistant cupro-nickel tubes are replaceable by means of heavy duty couplings.

FOR STEAM PRESSURES UP TO 350 LBS. AND 600° F.

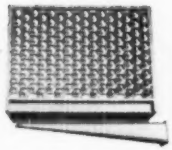
Type H Coils are available in a wide range of sizes for efficient application to any heating requirement. They are designed, tested and guaranteed for operation with steam pressures to 350 lbs. gauge and steam temperatures to 600°F.

FOR DETAILED INFORMATION ON AMERICAN BLOWER TYPE H HEAVY DUTY COILS, WRITE FOR BULLETIN B-1318 • FOR DATA ON OTHER AMERICAN BLOWER AIR HANDLING EQUIPMENT OR GYROL FLUID DRIVES PHONE OR WRITE THE NEAREST AMERICAN BLOWER BRANCH OFFICE

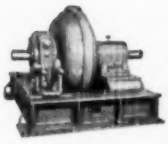
AMERICAN BLOWER CORPORATION, DETROIT 32, MICH.
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION



HS and Sirocco Fans for forced or induced draft in all types of power plants.



ST Fly Ash Precipitators—especially for power plants burning pulverized fuel.



Type V5 Gyrol Fluid Drive—for adjustable speed control of mechanical draft fans.

YOUR BEST BUY

AMERICAN BLOWER

POWER PLANT EQUIPMENT

Serving home and industry

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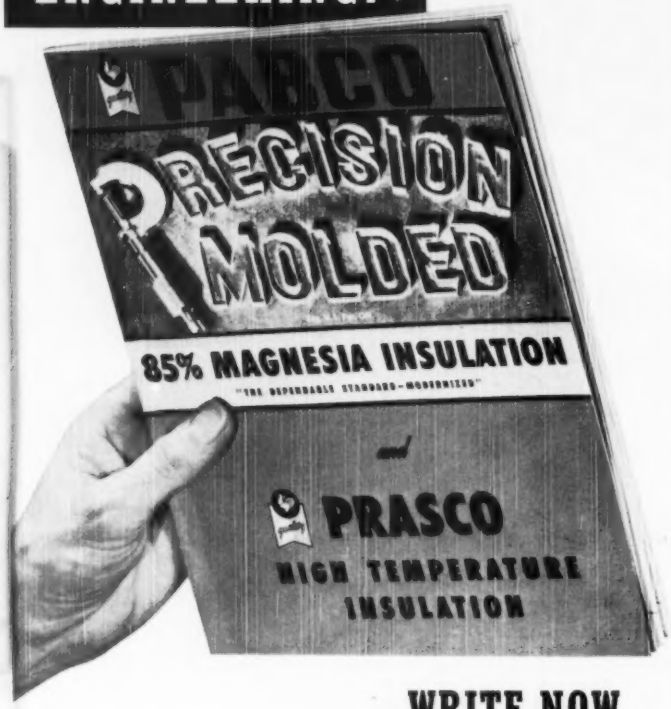

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- ★ Heat Transfer Data
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THE PARAFFINE COMPANIES, INC.
INSULATION DIVISION
San Francisco 19 New York 16
Manufacturers of Heat Insulation Since 1920

Corpus Christi, Texas; New Orleans, La.; Jackson, Miss. Branch houses that continue to report to Dallas are San Antonio, Fort Worth and Amarillo, Texas; Shreveport, La. J E Fontaine is assistant district manager in charge of new district. A W Palin and R B Hamilton are district operating manager and credit manager, respectively, for Houston and its branches. V A Elmblad is made assistant district manager of Dallas district. N M White, district operating manager, and W F Gay, district credit manager, of Dallas district continue to serve as such. Also, the sub-warehouse at Austin, Texas, is now a regular branch with E L Copeland, sales manager in charge, reporting to Dallas.

Phil R Becker has been named sales manager of welding fittings division of **Midwest Piping & Supply Inc,** St. Louis, Mo.

Riley Stoker Corp designates E J O'Connel sales engineer with headquarters at its Chicago office.

Appointment of J G Broz as sales manager of its 4-cycle diesel-engine dept is announced by **Nordberg Mfg Co,** Milwaukee. H M Cahill will assist Broz.

Graver Water Conditioning Co has selected the following as its sales engineering representatives: J R Fortune & Son, Detroit, Mich.; Stapp Engrg Co, Denver. Colo.; Process Equip Co, Tulsa, Okla.; Russell R MacDonald Co. Atlantic Life Bldg, Richmond, Va.; and Brookman-Kron Associates, 259 Delaware Ave, Buffalo, N. Y.

K W Horsman succeeds B R McBath, resigned, as works manager, Dunellen, N. J. works of **Worthington Pump & Machy Corp.**

Foxboro Co appoints Joseph M Temple manager of its branch office in Baton Rouge, La. He replaces John B Deaderick, who is now manager of the Tulsa office.

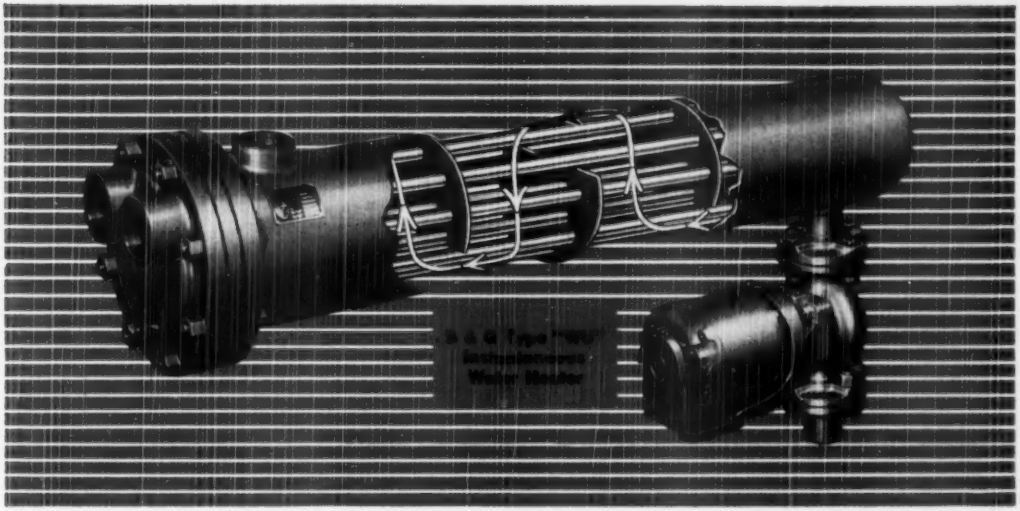
George H Dieter has been promoted to general sales manager of **Fluor Corp, Ltd,** Los Angeles, and R E Nagel to assistant sales manager in charge of Fluor's Chicago sales office.

Youngstown Sheet & Tube Co names L I Stead chief chemist for its Chicago district plants. He replaces Herbert McComb, who died recently.

Appointment of John E Payne as manager of **Westinghouse Electric Corp's** central district has been announced. Payne will have completed supervision of the firm's apparatus business in Pittsburgh, Cleveland, Detroit and Cincinnati areas. He will make his headquarters in Pittsburgh.

Fairbanks, Morse & Co, Chicago, announces following changes in its sales organization: J A Cuneo assumes duties of manager, Chicago branch. A M McLaren succeeds Cuneo as Los Angeles branch manager. John S King replaces J S Peterson as manager of Cincinnati sales area. Peterson is now attached to sales man-

THIS WATER HEATER CUTS COST 3 WAYS



MORE HOT WATER FROM A SMALLER UNIT . . . SMALLER INSTALLATION COST . . . NO STORAGE TANK NEEDED

Need lots of hot water? Here's the *economy way* to have it!

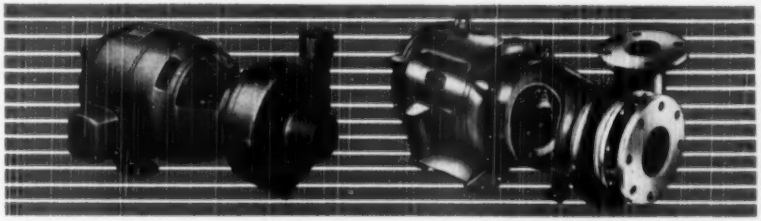
The "WU" Heater is equipped with a B & G Booster which pumps boiler water through the shell, greatly increasing the capacity of the Heater. You'll be amazed at the volume of hot water delivered by so small a unit.

Connecting pipes and fittings are greatly reduced in size because of pumped circulation . . . hence smaller material and installation costs. No expensive storage tank needed—the large heating surface of the "WU" heats water as fast as drawn. Correct baffling assures maximum heat transfer.

Positively controls service water temperature

Whenever service water drops below the desired temperature, the Booster starts automatically, pumping boiler water through the Heater shell. When the correct temperature is restored the Booster stops.

Write today for these catalogs of B & G Centrifugal Pumps and "WU" Water Heaters



GET THE FACTS ON B & G CENTRIFUGAL PUMPS

These pumps will meet your most critical appraisal. Made in a wide range of capacities with open and enclosed impellers. Series 1522 and 1531 Pumps feature a Mechanical Seal which eliminates stuffing box drip. Send for engineering data—you'll appreciate the outstanding design and workmanship of B & G Centrifugal Pumps.

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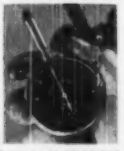
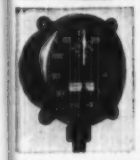
TACHOMETERS

TYPE "U"
UNIVERSAL CENTRIFUGAL TYPE
5 Ranges in 1 Instrument
Cat. No. 308 30-12,000 RPM
Cat. No. 314 45-18,000 RPM
Cat. No. 322 60-24,000 RPM
Cat. No. 346 120-48,000 RPM
Bulletin 750-N

MODEL J
TRIPLE RANGE CENTRIFUGAL
Cat. No. 312 300-12,000 RPM
Cat. No. 1412 100-12,000 RPM
SINGLE RANGES
100-1200 RPM, 200-2400 RPM
300-3600 RPM, 400-4800 RPM
Bulletins 760-N, 790-N

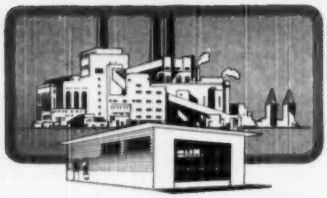


"JAQUET"
SPEED INDICATORS (CHRONOMETRIC)
Guaranteed Accuracy within ½ of 1%
Cat. No. 2301 0-10,000 RPM
Cat. No. 2302 0- 1,000 RPM
Suitable double rated speed. 3 models, various accessories.
Bulletin 735-N



STATIONARY TYPE
MODEL "J"
Sizes, 3", 4", 5½", 8", 10", and 20" dial diameter. Flexible shaft driven.
Many standard ranges reading RPM, FPM, YPM, etc.
Bulletins 795-N, 796-N 797-N

HERMAN H. STICHT CO., INC.
27 PARK PLACE NEW YORK 7, N. Y.



Industrial Sound Control
QUIETS POWER PLANTS
ENDS ANNOYANCE COMPLAINTS
LOW EMPLOYEE MORALE
THREATS OF LEGAL ACTION
Due to Disturbing NOISE

Whether your equipment serves a city of millions, a small town, or just your own plant, ISC can solve the noise problem quickly and inexpensively. Investigate today.

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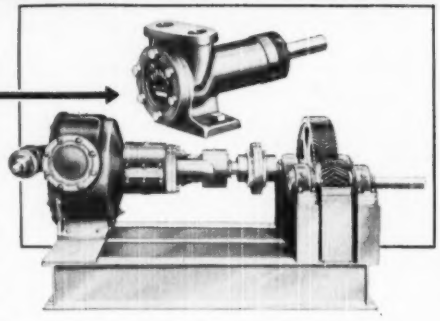
2118 Sepulveda Blvd., Los Angeles, Calif.

VIKING *Rotary* PUMPS

Range
FROM: ½ GPM
TO: 1050 GPM



If your problem is to deliver a clean liquid in any capacity from ½ to 1050 gpm, check the complete line of Viking rotary pumps. All are self-priming, non-pulsating and capable of delivering against pressures to 100 psi (200 psi in heavy-duty styles—500 psi on hydraulic oils).

The complete capacity range is available in either standard or special construction to meet your requirements.

Pumps are built to handle any liquid ranging in viscosity from L-P gas to grease. Check your requirements in bulletin 50SW.

Send for your free copy today.

VIKING
AN HONORED NAME IN PUMPING

See Our Catalog In SWEETS

Viking PUMP COMPANY
Cedar Falls, Iowa

ager's office in Chicago. William H Kingsley becomes manager of electrical div with headquarters in Chicago. R L Van Alstyne is made manager of all scale factories, maintaining his office in East Moline, Ill.

Geo B Limbert & Co Inc, 208 S LaSalle St, Chicago, has been chosen representative for **Dravo Corp.** The Limbert Co, headed by DeWitt C Showers and John D Purdy, will handle Dravo piping in the following territory—Illinois, Wisconsin, Minnesota, Iowa, northwest Indiana, western Michigan and St. Louis County, Mo.

Bridgeport Brass Co has added Donald H Waddington to the sales staff of its Atlanta office, where he will work under direction of James E Byrne, district manager. Waddington will handle sale of all Bridgeport products in states of Alabama and Mississippi.

Robert C Hood is elected president of **Ansul Chemical Co,** Marinette, Wis., succeeding his brother, F James Hood, who died recently. Ansul also created a dual vice-presidency, naming sales director Leonard C McKesson vice-president in charge of sales and Arthur C Pope vice-president in chage of manufacturing.

York Corp, York, Pa., transfers C Mason Gerhart to its home office as sales engineer. Raymond K Serfass becomes assistant general sales manager. In addition, Serfass will also, in the absence of John R Hertzler, general sales manager, assume authority and make such decisions as would ordinarily devolve upon the general sales manager. Serfass is succeeded by Alvin N Barnes Jr as industrial sales manager of North Atlantic district. Barnes will headquarter in New York.

Dean M Thomas, 1807 Elmwood Ave, Buffalo, N. Y., is new western New York representative for **Automatic Control Co.** In New Mexico area, Lou Hoffman, P O Box 1516, Albuquerque, will be the company's representative.

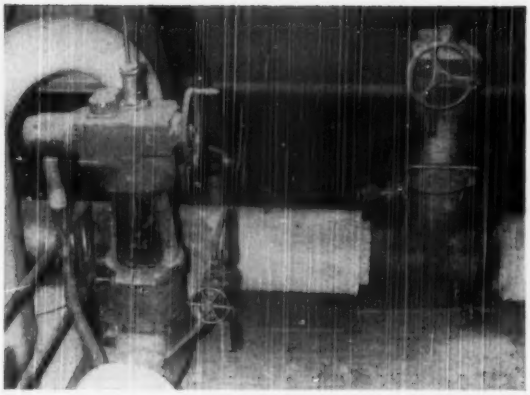
Air Reduction Sales Co, New York City, has promoted J H Berryman to assistant to Scott D Baumer, manager, technical sales division.

J C Kemp has been made district manager of **Ampco Metal's** Chicago office. R J Eckl assumes Kemp's former position as general sales engineer in the company's home office, Milwaukee, Wis. Also, Southern Engine & Pump Co, Houston, Texas, has been selected as distributor of the Ampco centrifugal pump line.

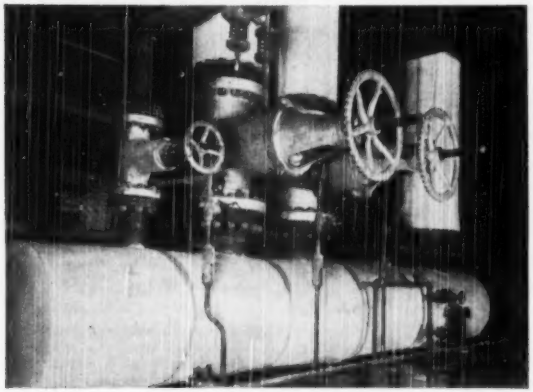
American Wheelabrator & Equip Corp, Mishawaka, Ind.; appoints Robert T Pring technical director of its dust and fume div. J Robert Bunch is now sales representative assisting J D Alexander in the Cleveland sales office.

A B Agnew is elected a director of **Laclede-Christy Co,** St. Louis, Mo.

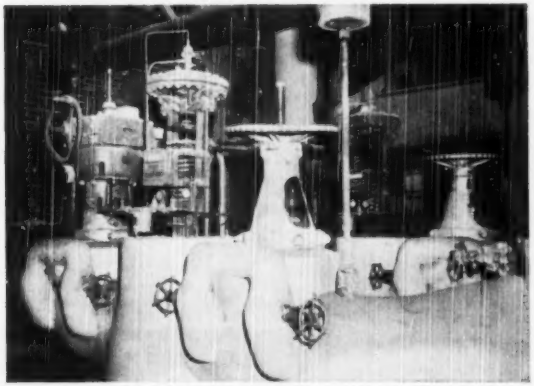
William J Russell, assistant manager of **Dowell Inc,** Tulsa, Okla., and Nelson D Griswold, assistant general manager of



Walworth Motor Operated Series 900 Pressure-Seal Cast Steel Gate Valves.



Walworth Series 600 Pressure-Seal Cast Steel Gate Valves.



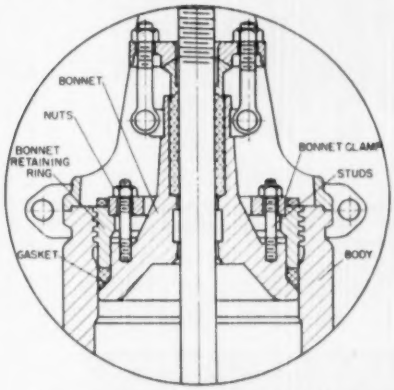
Manually operated and motor operated Walworth Series 900 Pressure-Seal Cast Steel Gate Valves.

WALWORTH
PRESSURE-SEAL
CAST STEEL VALVES

The bonnet and body design of Walworth Pressure-Seal Valves is such that the pressure within the valve is used to prevent leakage at the junction of the bonnet and body. Sudden temperature and pressure changes do not affect this tightness. Bonnet flanges and studs are eliminated and the weight of the valve is reduced.

An improved disc design provides flexibility, and helps keep seats tight, even when the valve body may be distorted by pipeline stresses, or by temperature and pressure changes. This improved disc design makes it easier to open and close this valve.

Walworth Pressure-Seal Valves are easy to disassemble and assemble, and are the most satisfactory valves for high-pressure, high-temperature service. They are available in Series 600, 900, and 1500 and in a wide range of sizes and types. For further information, see your nearest Walworth Distributor, or write: Walworth Company, 60 East 42nd Street, New York 17, N. Y.



A cross section of the bonnet joint assembly of a Walworth Pressure-Seal Cast Steel Gate Valve. The internal pressure is utilized to make the body-to-bonnet joint tight.

WALWORTH
valves and fittings
60 EAST 42nd STREET, NEW YORK 17, N. Y.

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ATLAS
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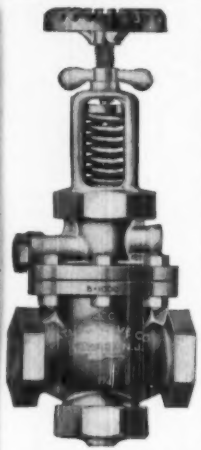
STEAM REDUCING VALVES

ATLAS Type "B" Steam Reducing Valves, shown below, are now STELLITED. The Pilot Valve is made entirely of that "WONDER METAL." And the Seat is STELLITE faced.

Type "B" is unequaled for services that require tight seating and uniform reduced pressure. With this remarkable STELLITED valve wide fluctuations in initial pressure have practically no effect on the reduced pressure because of the pilot operation. Renewable piston chamber, internal pilot valve and main valve strainers. Main valve disc seats tight because disc stem is guided by center bearing cast integral with seat ring. Control diaphragm and controlled pressure port are integral with the valve body. The main valve is caused to open wide and close tight with slight changes in the reduced pressure through the operation of the pilot.



This excellent valve is also simple to maintain. Main valve disc and pilot valve are easily removed for cleaning or regrinding. The entire pilot valve can be lifted out by merely removing diaphragm cap and unscrewing pilot valve seat.

When ordering reducing valves, always give the initial and reduced working pressure.

If interested, ask for Bulletin No. 1-A, which, in 52 pages, covers ATLAS Regulating Valves—for steam, water, air, gas, or oil.

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☐ Without obligation, please send me the ATLAS Regulating Valve Bulletin No. 1-A. Also, please send complete information on the following ATLAS products:

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☐ Temperature Regulators	☐ Oil Control Cocks
☐ Exhaust Control Systems	☐ Humidity Controllers
☐ Pressure Regulators	☐ Thermostats
☐ Campbell Boiler Feed Water Regulators	☐ Balanced Valves
	☐ Control Valves

Name .....

Firm .....

Address .....

Freeport, Texas plant of Dow Chemical Co, have been elected to the board of directors of Dowell.

Maguire Machy Co Inc, is now located in new offices at 60 E 42nd St, New York, N. Y.

American Brake Shoe Co announces that Paul L McCulloch Jr is transferred to Pittsburgh, Pa. district sales office where he will serve as sales engineer for American Manganese Steel and Electro-Alloys divisions of the company. He replaces M A Zeller who resigned.

Borg-Warner Corp has made Robert G Holmes branch manager of Chicago sales office of its Morse Chain Co division. Also, Robert A Anderson has been named vice-president and works manager of its Ingersoll Steel Division's Kalamazoo, Mich. plant.

Bruce S Williams becomes assistant to the president of **Russell Mfg Co.** He will make his headquarters at the firm's home office in Middletown, Conn.

OBITUARIES

J A Schallenberg, assistant comptroller, Worthington Pump & Machy Corp, Harrison, N. J., died Dec 16 after a long illness.

L E Bogen, former engineer in the motor and generator section of Allis-Chalmers' electrical dept, died Dec 3 in Cincinnati, Ohio.

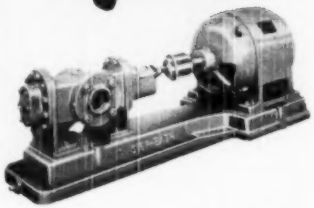
Mrs Katherine Gordon, 74, sales representative in Providence area for New York & New Jersey Lubricant Co, died Nov 30 at her home in Providence, R. I.

Allis Chalmers Mfg Co has released its year-end summary in its *Annual Review*. This report reveals engineering, product and research developments, aimed at providing power plants with efficient equipment for more economical operation. Steam-turbine shipments equaled the record set in 1948. Condensers reached the highest total of sq ft of cooling surface ever shipped in a peacetime year by Allis Chalmers. Two new lines of equipment for utility plants were announced during the year. They were: boiler feed pumps for operation in the 1200- to 2500-psi range; axial-flow compressors, to utilize from two stages upward.

Worthington Pump & Machinery Corp has conducted the final tests on its new *Uniflo* gas-engine compressor. The tremendous growth of gas-transmission lines during the last few years has made reliability and high efficiency important in gas engines that pump natural-gas fuel to population centers.

Minneapolis-Honeywell Regulator Co will promote and sell the products of its recently acquired **Belfield Valve Div** through 74 Honeywell branch offices in the U.S.A. Canada and Europe, according to a statement by L M Morley, vice-president and general sales manager of the Brown Instruments Div.

VISCOSITY
means nothing to the
SIER-BATH
SCREW PUMP



THIS pump is recommended for liquids of all viscosities, ranging from fluids such as solvents, to highly viscous substances similar to molasses, grease, Bunker "C" oil, cellulosics, etc.

Sier-Bath Pumps give sustained volumetric efficiency, even when handling non-lubricating liquids, because there is no metallic contact between rotors. This reduces wear caused by erosion.

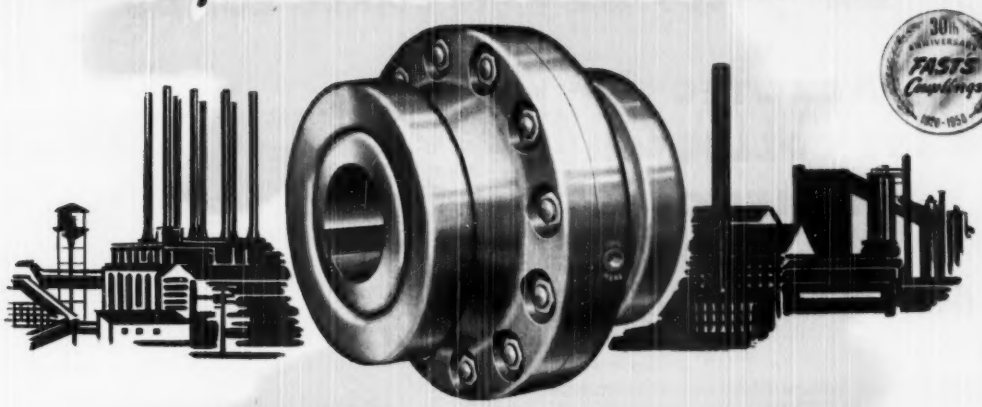
Axial flow from ends to center eliminates thrust bearings and high radial loads on roller bearings. The stuffing box is subjected only to suction pressure, thereby reducing leakage and packing maintenance to a minimum.

Large diameter shafts, sturdy rotors, high load capacity bearings and deep stuffing boxes for heavy duty services are characteristics of Sier-Bath Pumps. Available in horizontal and vertical models. Send for Bulletin S-3.

Also Manufacturers of Sier-Bath Gear Couplings and Precision Gears

Sier-Bath
FOUNDED 1905
GEAR and PUMP CO., Inc.
9254 HUDSON BLVD., NORTH BERGEN, N. J.

NOW - you can FORGET COUPLING SHUTDOWNS—



INDUSTRY REPORTS—

KOPPERS ENGINEERING STOPS COSTLY FAILURES

In oil fields, steel mills, power plants . . . all through industry . . . cost-wise executives report that *Fast's Couplings*, designed, manufactured and guaranteed by Koppers, are the best insurance against coupling failures! Take a tip from these users who know. Specify Fast's and forget *your* coupling problems!

By specifying Fast's, you get the benefit of Koppers Engineering Service, acknowledged best in the industry. Koppers Engineers, backed by 30 years coupling experience, study your problem . . . then show you *which* Fast's Coupling fits your application, (and more important) *why* you need it!

Only Koppers can offer you this valuable service . . . only Koppers offers Fast's, the original gear-type coupling. Fast's Couplings assure you freedom from expensive coupling failures in your plant because Fast's have no perishable parts to fail!

GET THE FACTS: Mail coupon today for your free copy of the Fast's Coupling Catalog, published by Koppers. Shows how Fast's operate, describes the many sizes and types. Gives full details about Koppers Engineering Service. Send for your copy today.

These FAST'S COUPLING *Services save you money!*

UNSURPASSED ENGINEERING . . . *Koppers Engineers are acknowledged the best in the coupling industry. Their practical knowledge, backed by 30 years of coupling experience, is at your service!*

IMMEDIATE DELIVERY . . . *All standard types and sizes are available for immediate delivery from "on hand" stocks. In case of emergency, just wire factory for special rush delivery!*

LOWEST COST PER YEAR . . . *Fast's Couplings will outlast equipment they connect if properly maintained. Their cost may be spread out over 25 years or more, offering you lowest coupling cost per year!*

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FAST'S

THE ORIGINAL GEAR-TYPE

Couplings

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222 Scott Street, Baltimore 3, Md.

Please send me a free copy of your Fast's Coupling Catalog.

Name.....Title.....

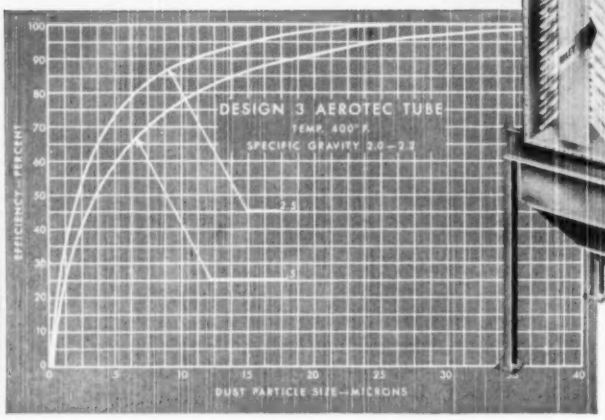
Company.....

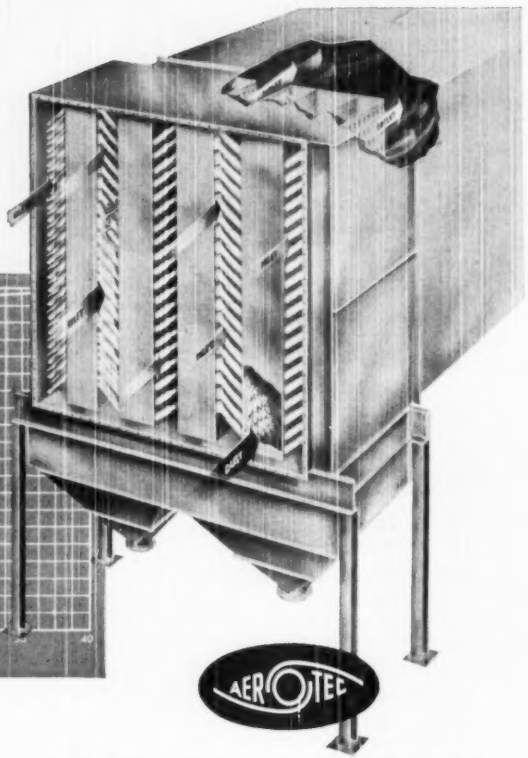
Address.....

City.....Zone.....State.....

ON *Full* OR *Partial* LOADS

AEROTEC DUST COLLECTOR EFFICIENCY *is still high*





Keeping efficiency high on a fluctuating boiler load is important in meeting dust ordinances. The Aerotec Design 3RAS Collector has solved this problem by the use of small diameter tubes.

It will be seen from the curve that 2.5 w.g., efficiency on 20 micron particles, at full load, is 98%. Reducing the load to 0.5 w.g., equivalent to half load, the Aerotec Collector still provides an efficiency of 91.5%, ample to meet most dust ordinance requirements encountered.

These small diameter tubes also provide a compact unit that will fit into almost any space requirement, a factor that is extremely important when the installation is made in an existing power plant where space is usually at a premium.

Project and Sales Engineers

THE THERMIX CORPORATION

Greenwich, Conn.

(Offices in 28 Principal Cities)

Canadian Affiliates: **T. C. CHOWN, Ltd.,** *1440 St. Catherine St., W., Montreal 25, Quebec*

THE AEROTEC CORPORATION

GREENWICH, CONN.

Zallea Expansion Joint News

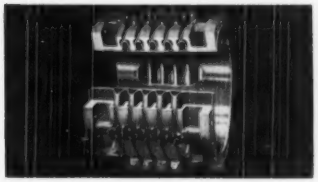
PUBLISHED BY ZALLEA BROTHERS—WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS EXCLUSIVELY

Expansion Joint of the Month

PROTECTING $100,000 A DAY

DUO EQUALIZING TYPE

The ideal corrugated expansion joint is one in which all corrugations move simultaneously during expansion or contraction of the piping, and no corrugation can be compressed or extended more than the proportionate amount for which it is designed. This briefly describes the Zallea Duo Equalizing Expansion Joint, so called because it functions in two ways: equalizing the compression among the corrugations simultaneously when the pipe line is expanding and likewise distributing the elongation simultaneously and proportionately among all the corrugations when the line is contracting.



This is accomplished by the simple expedient of a pantograph. Two or more pantographic chains are superimposed on the equalizing rings of the expansion joint, the neutral points being anchored in the end fittings and intermediate equalizing rings. Any movement of the end fitting is immediately and simultaneously transmitted to all equalizing rings. In this manner all the equalizing rings move the same relative distance at the same time. This Zallea Joint is recommended for all intermittent steam services in long lines, institutions, and industrial plants.

. . . a complete, practical catalog on all Zallea Expansion Joints. A text book and a valuable reference source. Send for your *free* copy *today!*

ZALLEA BROTHERS, 814 Locust Street
Wilmington 99, Delaware.

Control in Manufacture

COPPER VS. STAINLESS STEEL

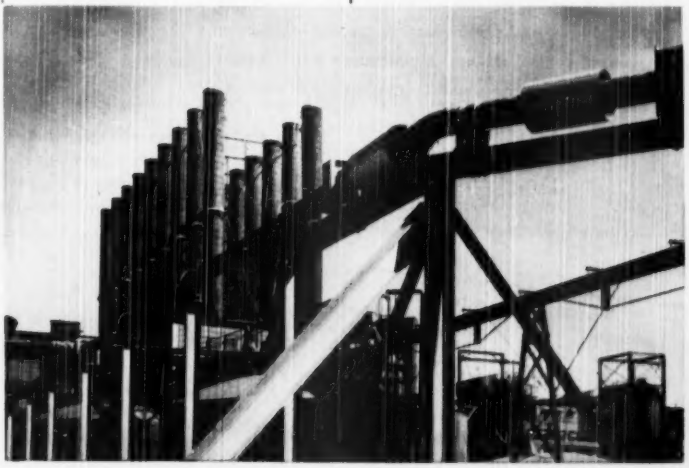
For many years, copper has been the accepted material for the corrugated elements of packless expansion joints for use on heating lines, pumps, turbines and condensers. However, with new expansion problems demanding higher strength and greater corrosion or temperature resistance, stainless steel has replaced copper in approximately 95% of the applications. Although slightly higher in initial cost, the use of stainless steel results in much lower final costs because of increased service life. Stainless steel corrugated elements can be made with a wall thickness approximately one-third of that required for copper to withstand the same working pressure. Since the life expectancy of a corrugated element varies inversely with the thickness of the metal, a stainless steel expansion joint will last many times longer than a copper expansion joint designed for the same operating pressure. The stainless steel used in the Zallea Expansion Joint may be of several alloys, depending upon temperature, corrosion and other service requirements.

ZALLEA EXPANSION JOINTS GUARD PLANT CAPACITY

At a large eastern industrial plant which has a production capacity of over $100,000 per day, Zallea Stainless Steel Expansion Joints serve as insurance against shutdown and costly delay. Failure of any one of the many expansion joints that are installed in the outdoor steam distribution line would result in major production loss. But the Zallea Joints installed here in 1933 still function safely and dependably. It's the *quality* built into every Zallea Expansion Joint that makes them last!

No Maintenance Required

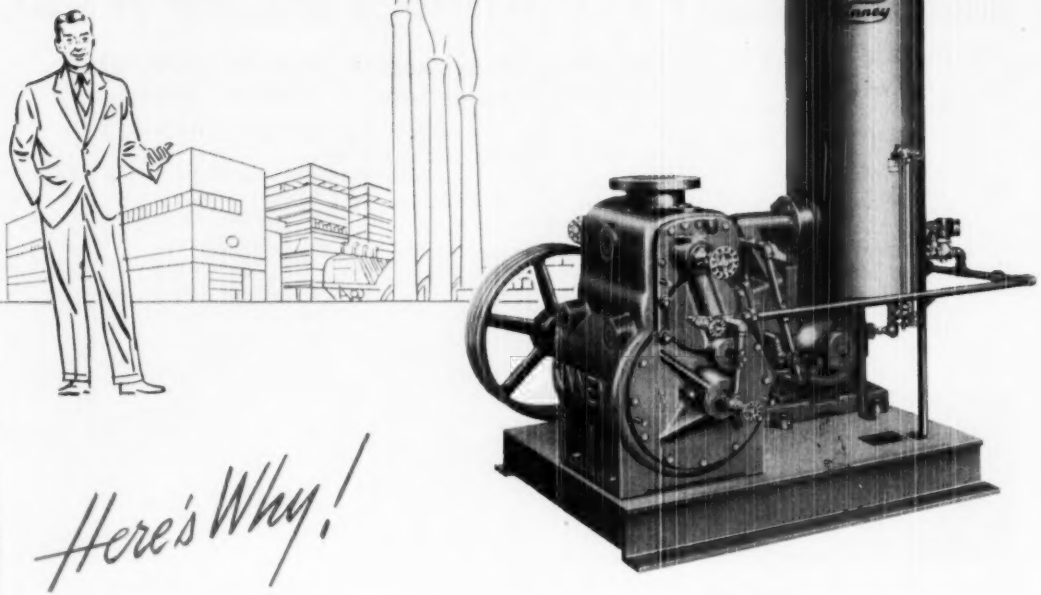
Built expressly to absorb expansion and contraction of pipe lines due to thermal changes, Zallea Stainless Steel Expansion Joints will serve dependably and economically under the severest of installation operating conditions. There's no packing to deteriorate—no maintenance is required. For normal steam line operation, Zallea Stainless Steel Expansion Joints will outlast the line itself!



(Advertisement)

MODERN GENERATING PLANTS ARE INSTALLING

KINNEY VACUUM PUMPS



Here's Why!

- The Kinney Rotary Vacuum Pump has sufficient capacity to eliminate the need of auxiliary evactors to create condenser vacuum. This pump is highly efficient over the full range of pressures from atmospheric down to a small fraction of an inch Hg. abs.
- The Kinney Rotary Vacuum Pump can be started and stopped by push-button controls, located remotely at central control stations. Maintenance and constant supervision of tricky reducing valves are eliminated.
- The Kinney Rotary Vacuum Pump removes corrosive gases — prevents concentration of harmful ammonia, carbon dioxide, and other boiler water contaminants. This pump also helps conserve valuable condensate.
- The Kinney Rotary Vacuum Pump makes possible the ideal piping layout: a single steam line from boiler to turbine. No need for auxiliary high-pressure lines and reducing valves to "hogging jets".

If you're working with steam pressures of 1000 psi or more and high temperatures, look ahead — follow the leading steam generating stations. Install Kinney Vacuum Pumps. For Brochure describing "Use of Mechanical Vacuum Pumps in Central Station Operation" and Bulletin V-45, write Kinney Manufacturing Company, 3532 Washington St., Boston 30, Mass.

Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle.

FOREIGN REPRESENTATIVES

GENERAL ENGINEERING CO. (Radcliffe) Ltd., Station Works, Bury Road, Radcliffe, Lancashire, England
HORROCKS, ROXBURGH PTY., LTD., Melbourne, C. 1, Australia
W. S. THOMAS & TAYLOR PTY., LTD., Johannesburg, Union of South Africa
NOVELECTRIC, LTD. Zurich, Switzerland

KINNEY Vacuum Pumps

- ✔ Assured Safety
- ✔ Efficient Operation
- ✔ Minimum Fuel Costs
- ✔ Low Maintenance
- ✔ Long, Trouble-Free Life

MADE SIMPLE BY NAVCO

The high degree of skill acquired by Navco Engineers from long experience in solving unusual Piping problems is your guarantee of an accurate and workmanlike Piping System.

Consult Navco for your next Piping Job

NAVCO

NAVCO PIPING

NATIONAL VALVE & MANUFACTURING COMPANY • PITTSBURGH, PA.

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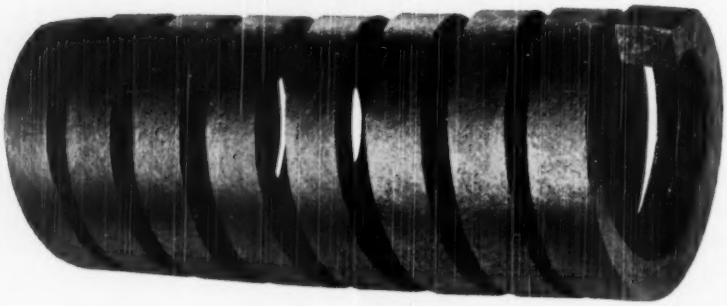
versi-pak®

A NEW AND HIGHLY VERSATILE PLASTIC PACKING



versi-pak is the result of more than two years of testing and development. This new plastic packing can be used in an exceptionally large number of applications, and simplifies storage and inventory problems. It is being used successfully in reciprocating and centrifugal equipment and in hydraulic systems. Recommended for temperatures up to 350°F.; pressures up to 600 p.s.i.; against air, water, low-pressure steam, and a long list of chemicals. Available also in non-graphited form (R/M No. 1846) for use in food-handling equipment. For your free copy of the new bulletin on **versi-pak** send the coupon below to the Packing Division, Manheim, Pa.

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.
No. Charleston, S.C.; Passaic, N.J.

Raybestos-Manhattan, Inc.
Packing Division, Manheim, Pa.

Gentlemen: ☐ Please send me a free copy of the **versi-pak** bulletin.

Name_____

Position_____

Company_____

Address_____

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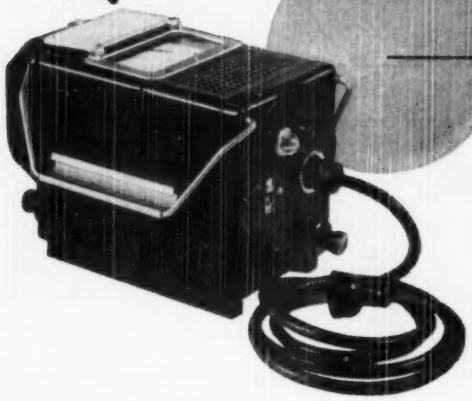
RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Asbestos Textiles Mechanical Rubber Products • Abrasive and Diamond Wheels • Rubber Covered Equipment Brake Linings • Brake Blocks • Clutch Facings Fan Belts • Radiator Hose • Powdered Metal Products • Bowling Balls

NEW "MEGGER"* Rectifier-Operated Insulation Testers

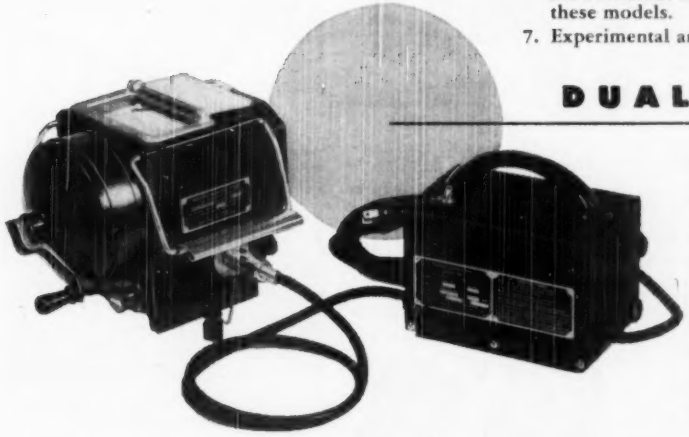


RECTIFIER-OPERATED

. . . in which a transformer and rectifier replaces the usual hand-cranked generator. It operates simply by plugging into 115 v. 60 cycles.

Typical Applications include:

1. Production testing of all types of electrical equipment and components.
2. Testing multi-conductor communication cables, as in telephone plants.
3. Testing multi-conductor control circuits in power plants.
4. Acceptance tests, such as from load centers, in lighting and power installations.
5. Testing multi-conductor control and power circuits at central locations in railway signal installations.
6. Testing generators, cables and other equipment by the time-resistance method, where the dielectric absorption or leakage current of the insulation under test is high enough to bring the resistance measurement within the range of these models.
7. Experimental and laboratory use.



DUAL-OPERATED

. . . a combination of the popular, constant-voltage, hand-cranked set, and a separate rectifier. It can be operated either by hand or by the rectifier connected to 115 v. 60 cycles. This Dual-Operated instrument has the same applications as the instrument above, *plus* the fact that the basic, hand-cranked instrument is available for test problems normally encountered in the field.

• *For full particulars please write for new illustrated Bulletin 21-46-P.*

*REG. U. S. PAT. OFF.

JAMES G. BIDDLE CO.

Electrical & Scientific Instruments

1316 ARCH STREET, PHILADELPHIA 7, PA.

"Megger" INSULATION TESTERS • GROUND TESTERS • OHMMETERS

POWERS

NO. 11 TEMPERATURE REGULATOR—*Controls Temperatures of Liquids or Air*

4 PLUS VALUES

1. **OVER-heat Protection**
2. **Valve Stem Lubricator**
3. **Temperature Adjustment has OILITE Thrust Bearing**
4. **Indicating Regulator Available** *

Simple, Self-Operated, Economical —Dependable

Give

BETTER TEMPERATURE CONTROL

and Extra Years of Dependable Service

OFTEN PAYS BACK ITS COST SEVERAL TIMES EACH YEAR

When you want a simple dependable control to maintain a constant uniform temperature install a Powers No. 11 Regulator.

PREVENTS OVER-HEATING—SAVES FUEL and LABOR

HELPS INSURE A UNIFORM PRODUCT • MANY GIVE 10 to 25 YEARS OF SERVICE

For valuable aid in selecting the proper type and size of regulator take advantage of our 59 years of experience. Contact our nearest office or write to • THE POWERS REGULATOR CO., 2756 Greenview Ave., Chicago 14, Ill. • 231 E. 46th St., New York 17, N. Y. • 1808 W. Eighth St., Los Angeles 5, Cal. • 195 Spadina Ave., Toronto, Ont.

WRITE FOR BULLETIN No. 329

THE POWERS REGULATOR CO., 2756 Greenview Ave., Chicago 14, Ill.

Gentlemen: Please send me Bulletin 329. Am interested in

control for.....

Name..... Title.....

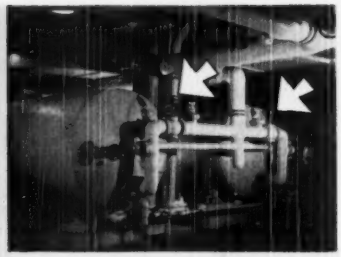
Firm Name.....

Address.....

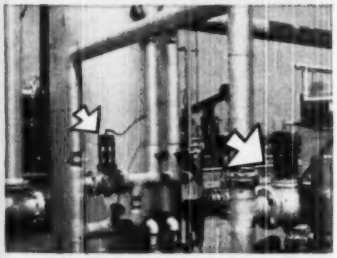
A-11

NO. 11 INDICATING REGULATOR

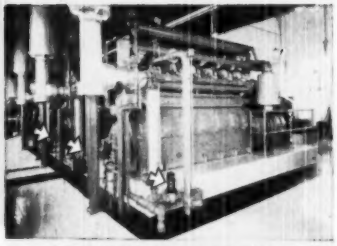
Has 4" Thermometer dial mounted on top of regulator. Both thermometer and bulb operate from same thermal system. Only one tapped opening required. Gives visual check on performance of regulator. Makes it easy to adjust for the right temperature.



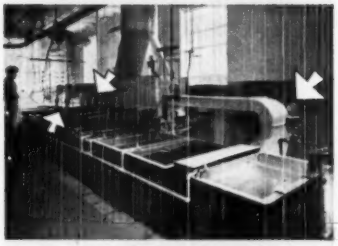
For WATER HEATERS and HEAT EXCHANGERS



For OIL HEATERS and TREATERS



For JACKET WATER COOLING IN DIESEL and GAS ENGINES



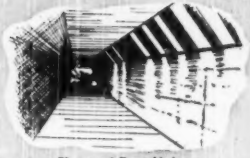
For METAL PLATING above below COOKING VATS

WHERE TO USE LUMNITE IN POWER PLANTS

Steel Stack Linings

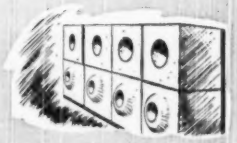
Ash Pit and Cinder Catcher Linings

Coal Bunker Linings



Flue and Duct Linings

Overnight Structural Concrete

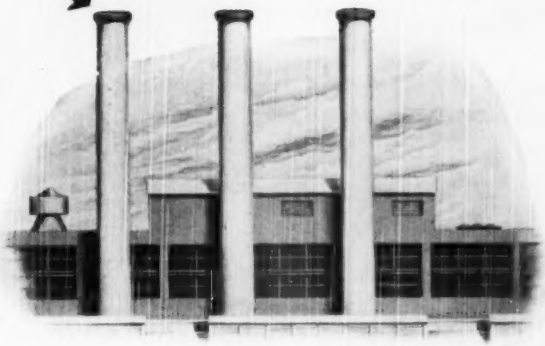


Castable Refractories

Factory-prepared mixtures of LUMNITE and selected aggregates. Mixed with water on the job, cast into place for door linings, arches, baffles, furnace walls. Special shapes can be cast in molds, ready within 24 hours. Castables to meet different temperatures and insulation needs are made by refractory manufacturers, sold by their distributors.

STOP CORROSION... IMPROVE DRAFT

with LUMNITE*STACK LININGS



Your steel stacks get full protection from corrosion and heat when LUMNITE linings are installed. These linings boost drafts by keeping gas temperatures up. They resist attacks of condensate and sulphurous gases. Linings are jointless, allow no "breathing." LUMNITE thus adds years of service to old stacks. In new stacks, LUMNITE heat- and corrosion-resistant concrete protects the steel indefinitely.

LUMNITE linings are easily installed. Reinforcing mesh is attached to steel angles or other projections welded to the steel shell . . . the mixture of LUMNITE and insulating corrosion-resistant aggregate is applied over the reinforcing mesh. Ready 24 hours after installation, LUMNITE linings reduce outage time to a bare minimum.

In stacks, as well as other power plant installations, listed in the column at left, LUMNITE provides high structural strength, high heat resistance and low thermal conductivity.

**"LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company*

P-L-2

Lumnite Division

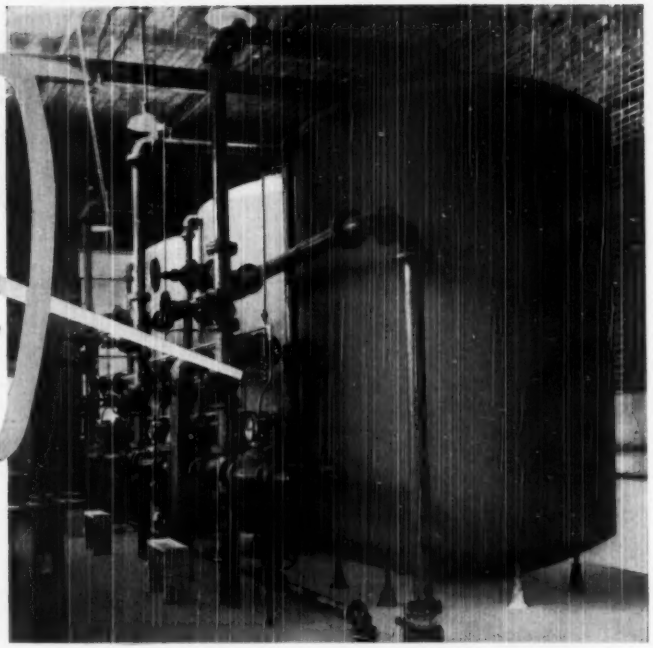
UNIVERSAL ATLAS CEMENT COMPANY

UNITED STATES STEEL CORPORATION SUBSIDIARY

135 EAST 42nd STREET • NEW YORK 17, N. Y.

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—NBC Network*

ZEOLITE is right for purifying water here...



Worthington installation of three 8′ — 0″ dia. Sodium Zeolite Softeners put into operation in August, 1948 at Virginia Woolen Co., Middlebury, West Virginia. Here raw creek water is alum treated, settled, filtered and softened. Virginia Woolen Co. constructed its own filters.

. . . but it may not be right for your water treatment

This Worthington Ion-Exchange plant was installed for purifying water in this case, *only* after scientific analysis by Worthington engineers determined that it was the most economical process for Virginia Woolen Co.

In your case, there are so many variables involved that a similar analysis would have to decide which water conditioning process is right for you. Even within the ion-exchange process itself, there are many variables: what ions you want to get rid of . . . calcium, magnesium, sodium, bicarbonate, sulphate or chloride; whether or not you want alkalinity removed; whether you want ionized water comparable to distilled water. *Only* scientific study of your particular water conditions can determine the right process for you.

WORTHINGTON KNOWS ALL FOUR PROCESSES

Out of Worthington's century-old experience in engineering water handling equipment has come more knowledge and skill in solving complicated water conditioning problems than you can get anywhere else. And since Worthington alone makes every essential part of all kinds of water conditioning systems, you get the extra advantage that comes from placing complete control and responsibility in the hands of one reliable manufacturer.

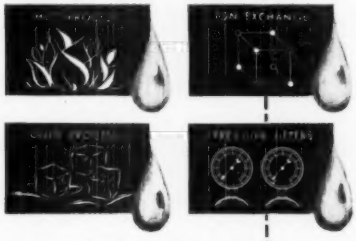
For complete details about the Worthington Ion-Exchange process, and further proof that *there's more worth in Worthington*, write for Bulletin W-212-B4. *Worthington Pump and Machinery Corporation, Water Treating Division, Harrison, New Jersey.*

J8-6

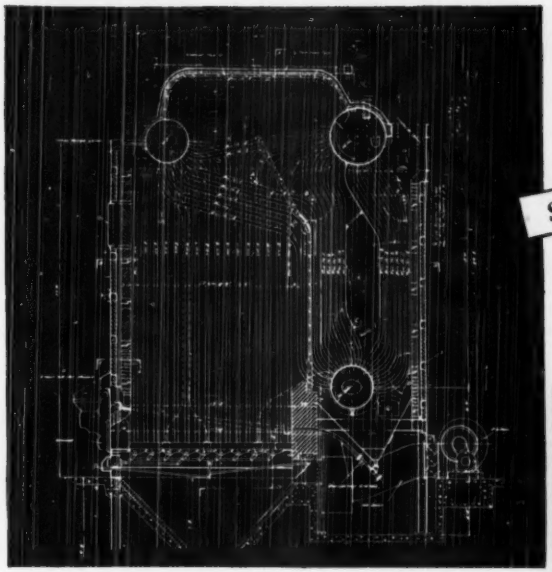
WORTHINGTON

WATER CONDITIONING

Worthington Makes More of the Equipment for All Types of Water Conditioning Systems



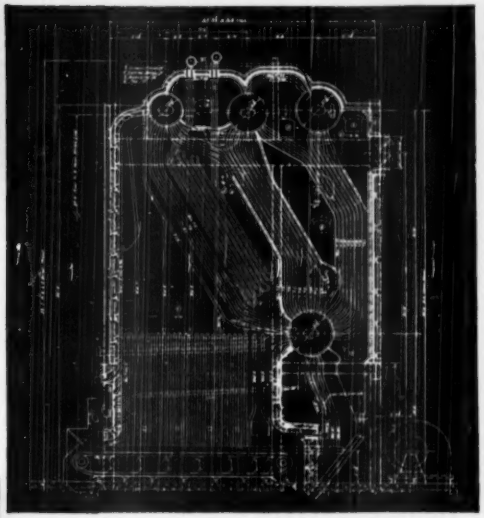
Quick Steaming at all Ratings!



Carry high overloads with high efficiency

SPECIFY **Vogt**

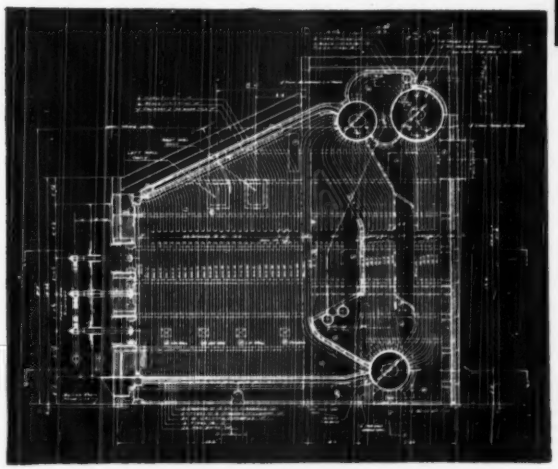
STEAM GENERATING UNITS



CLASS VL Two 27,500 pounds per hour, units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mt. Carmel Public Utility, Mt. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.

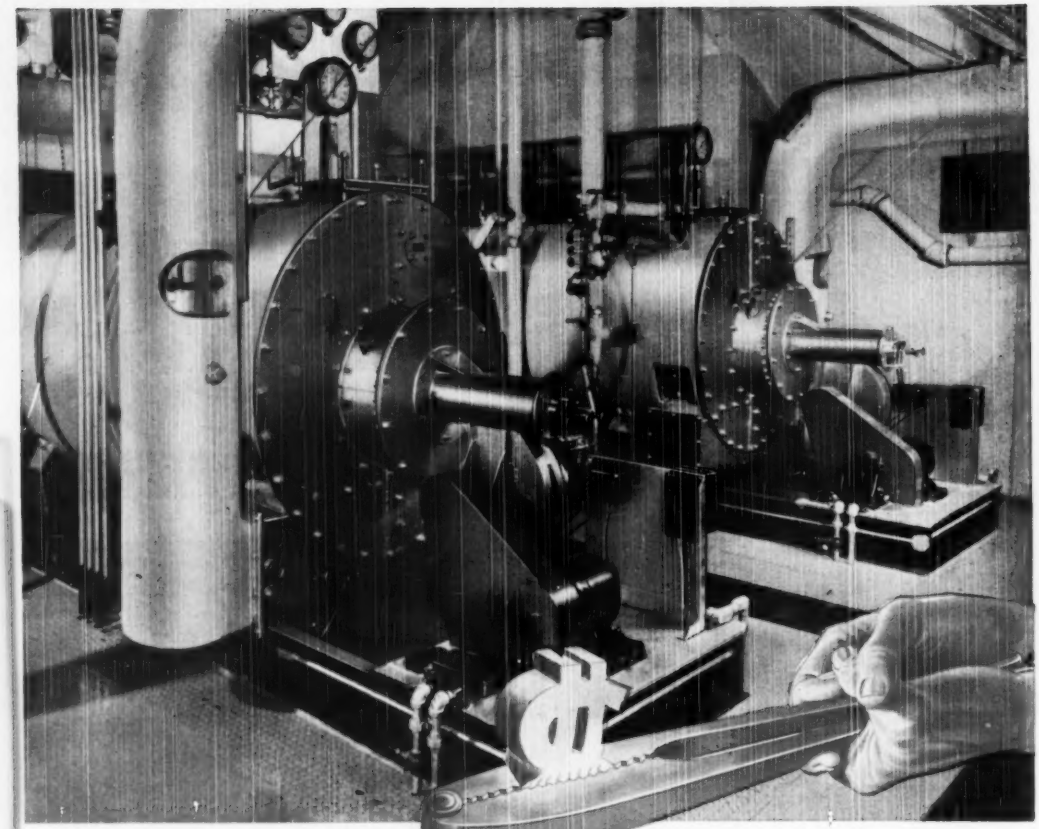


Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

BRANCH OFFICES:
NEW YORK, PHILADELPHIA, CLEVELAND,
CHICAGO, ST. LOUIS, DALLAS



Put the Squeeze on

Steam Costs

NEVER forget boilers burn dollars — dollars that represent steam costs and a goodly share of your operating costs. Conditions today demand that you put the squeeze on steam costs along with your other costs. Begin with your boiler — investigate to see how much it is giving you for your fuel and operating dollars — see if it measures up in earning power as well as horsepower.

For any boiler installation (15 to 500 HP.) — new or replacement — Cleaver-Brooks offers these immediate and long range cost-saving advantages:

A Custom-Planned Boiler Engineered for Your Needs: Your steam needs and steam-using equipment are studied — your present total steam load plus your estimate of future expansion are considered — with this information the size of Cleaver-Brooks Boiler best suited to your specific needs is determined.

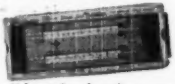
Factory Starting Service: Your boiler is placed in operation by Cleaver-Brooks factory service-engineers. Your operators are trained in operation, care and maintenance.

Flexible Operation Burning Gas or Oil With Equal Efficiency: You can use oil, gas, or combination oil and gas, whichever is of lower cost. Through their high heat transfer, Cleaver-Brooks boilers operate at a guaranteed efficiency of 80% from full load down to 30% of rating.

In addition, Cleaver-Brooks boilers give you clean, smokeless operation — eliminate fuel and ash handling — require no high or costly stacks — no special foundations — fit under low headroom — provide quick steaming, flexible operation to meet fluctuating loads — fully meet all codes.

Available in sizes 15 to 500 HP., 15 to 200 P.S.I. — write for Cleaver-Brooks steam boiler bulletin.

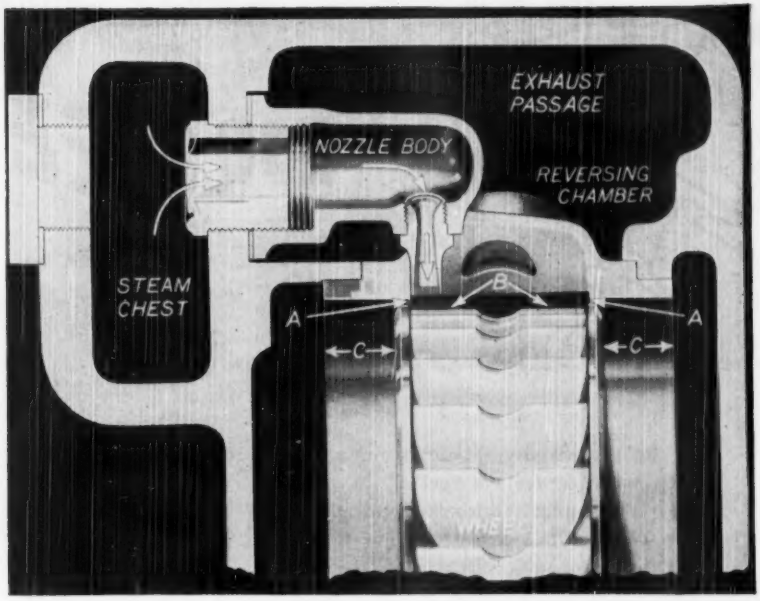
CLEAVER-BROOKS COMPANY
3332 E. Keefe Ave., Milwaukee 12, Wis.

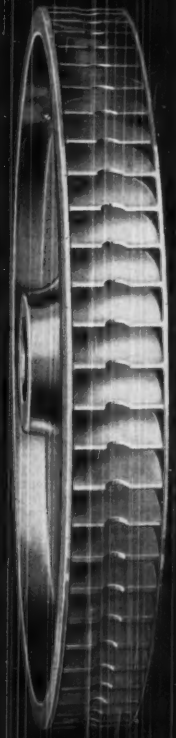


WRITE on your business letterhead for Steam Cost Calculator— a ready reference slide rule showing comparative steam costs when using oil, gas, or coal as fuel. Mailed on request — no obligation.

Cleaver-Brooks
STEAM BOILERS

TERRY





AMPLE CLEARANCES FOR DEPENDABILITY

Large blade and rim clearances and extra large side clearance — one inch — help make Terry One-piece Wheel Turbines highly dependable in operation.

The blades cannot foul because of the protection afforded by the rims, which are not damaged, should rubbing occur.

Note the rim clearance, AA in diagram. Also the large blade clearance, B. Side clearance, CC, is so large that end-play from external thrust cannot damage wheel.

Terry Bulletin S-116 will give you full information on the Terry Wheel Turbine. A request on your business letterhead will bring you a copy.

T-1171

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

"Me . . . stock all those endless V-Belt sizes?"

"Not since I use VEELOS"

"I can replace any V-belt in our plant with just these reels of Veelos."

That's a typical Veelos user telling you how Veelos cuts V-belt inventory. If you use O, A, B and C widths, four reels of Veelos give you a choice of more than 316 sizes. Use only A and B? Then two reels are all you need.

Buying matched sets of endless V-belts is costly. Forget it with Veelos. Forget, too, belt deterioration and obsolescence. Veelos on reels saves storage space . . . simplifies stock records.

Veelos is quickly and easily installed. On drives with fixed centers or outboard bearings, Veelos is installed without moving the motor or dismantling the machine. It provides substantial savings in installation and maintenance costs.

VEELOS
THE LINK
V-BELT

SEND FOR FREE VEELOS CATALOG. It shows how you can benefit from the many important advantages of Veelos. Fully illustrated. Complete engineering data. Write for it.

MANHEIM MANUFACTURING & BELTING COMPANY
MANHEIM, PA.

ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

Made in all standard sizes, fits all standard grooves. Packaged on reels in 100-foot lengths. Sales engineers in principal cities; over 300 distributors throughout the country. Veelos is known as VEELINK outside the United States.

SLUDGE OR SCALE?

There's no place for guesswork in boiler rooms. Scale and adherent sludge cause tube metal to overheat and fail. They often look alike—yet the cause and cure of each may be entirely different. Someone *has* to know this difference or your water treatment may fail.

*Sludge,** a water-formed sedimentary deposit, may include all suspended solids in the water. "Baked-on" sludge is hard and adherent, similar to scale.

*Scale** usually forms from solution directly in place on the surface. It is crystalline and dense in nature.

The Drew System of Water Treatment eliminates guesswork! It starts with proper diagnosis. Corrective treatment, modification of operating cycles, redesign of equipment and other preventive measures are recommended when required. The Drew System is more than superficial service . . . more than chemical "prescriptions" . . . it is specialized service, corrective treatment and preventive measures applied to your individual boiler problem.

*Brief ASTM definition. Send for additional information on the cause and cure of sludge, scale or other water problems.

POWER DREW CHEMICALS

Power Chemicals Division

E. F. DREW & CO., INC.

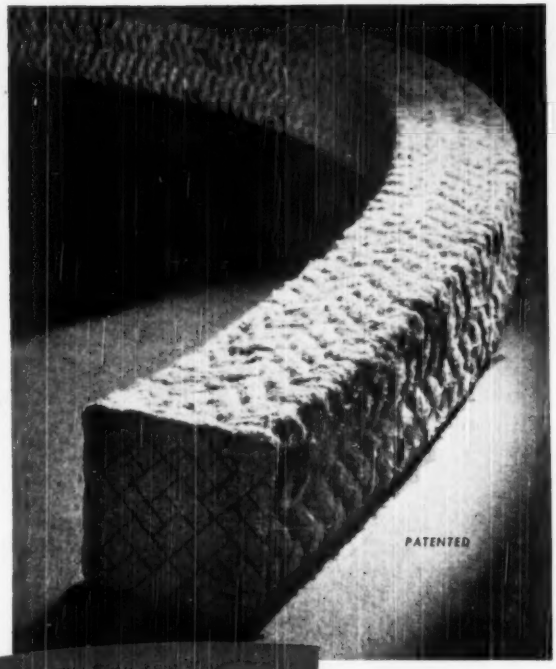
15 East 26th Street, New York 10, N. Y.

DREW PRODUCTS

Nationwide service in Boiler Water and Cooling Water Conditioning

QUESTION:

Which Garlock rod packing is braided through and through for longer life?



ANSWER:

LATTICE-BRAID

The unique structural design of LATTICE-BRAID packing gives it great strength, long life and unusual flexibility.

Supplied in several styles, including:

- GARLOCK 730 (asbestos)—for hot or cold water at medium to high pressures.
- GARLOCK 731 (asbestos)—for steam, gases or water at temperatures up to 700° F.
- GARLOCK 732 (asbestos—wire inserted)—for heavy duty service against steam, oil, gases or water at temperatures up to 700° F.
- GARLOCK 733 (asbestos)—for hot or cold water or alcohol at medium or low pressures.
- GARLOCK 734 (asbestos)—for cold gasoline, kerosene and light oils.
- GARLOCK 736 (blue asbestos)—for concentrated mineral acids.
- GARLOCK 740 (flax)—for cold water at medium or low pressures.
- GARLOCK 745 (flax)—for heavy hydraulic service against cold water.
- GARLOCK 751 (cotton)—for hot or cold water.

In GARLOCK LATTICE-BRAID *every braiding strand* passes diagonally *through* the body of the packing at an angle of approximately 45°. All the strands are strongly lattice-linked together into a structural unit which holds together even when the packing is worn far beyond the limits of wear of ordinary braided packings.

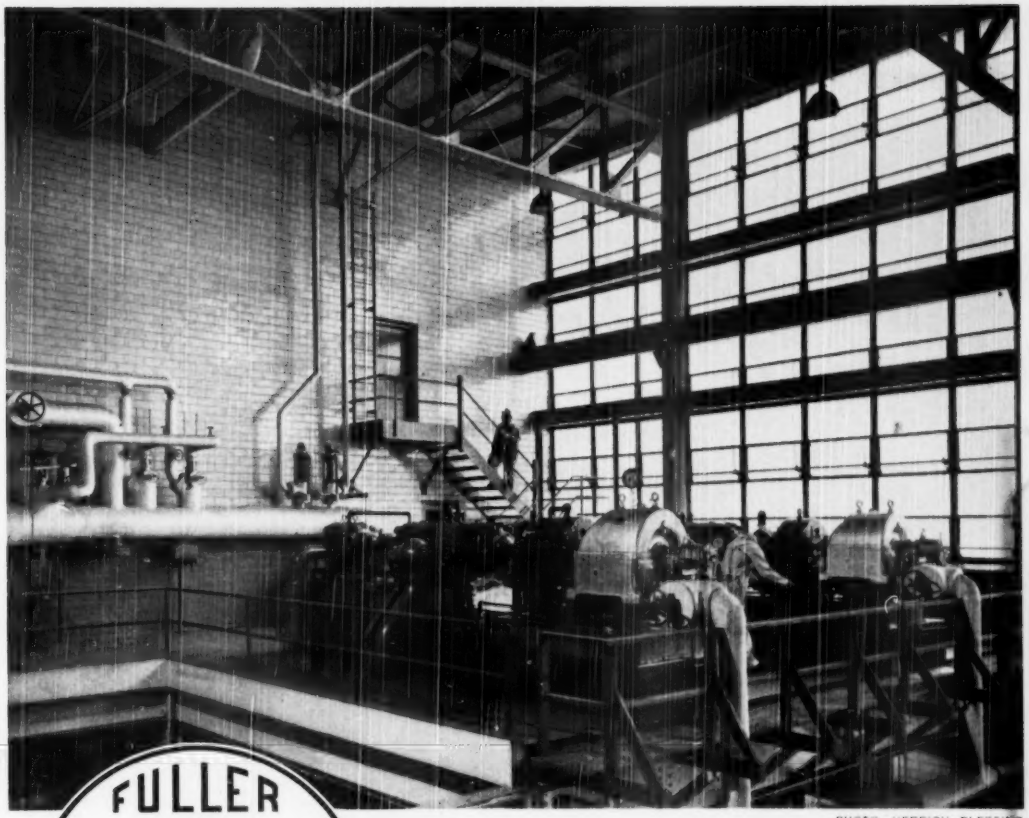
Write for folder!

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

GARLOCK

PACKINGS, GASKETS AND OIL SEALS



PHOTO—HEDRICH-BLESSING

FULLER ROTARY COMPRESSORS

in

SHERWIN-WILLIAMS

New Boiler House

Two Fuller Rotary Two-stage Compressors are installed in the new boiler house of The Sherwin-Williams Co., Chicago, shown above.

These compressors furnish air for both factory and power-house service. Each has a capacity of 1592 c.f.m., free-air, at 120-lb. pressure, driven by 350 hp. turbine, equipped with speed reducer, to operate at 575 r.p.m.

Fuller Rotaries are ideal units for any industrial plant. They are built in single and two-stage for capacities to 3300 c.f.m., actual free-air delivery, 125-lb. pressure; vacuums to 29.90-in. (referred to 30-in. barometer).

Bulletin C-5 illustrates and describes these machines. We will gladly send you a copy.

A LIFETIME OF NEW MACHINE EFFICIENCY

FULLER

FULLER COMPANY, CATASAUQUA, PA.

Chicago 3 - 120 So. LaSalle St.

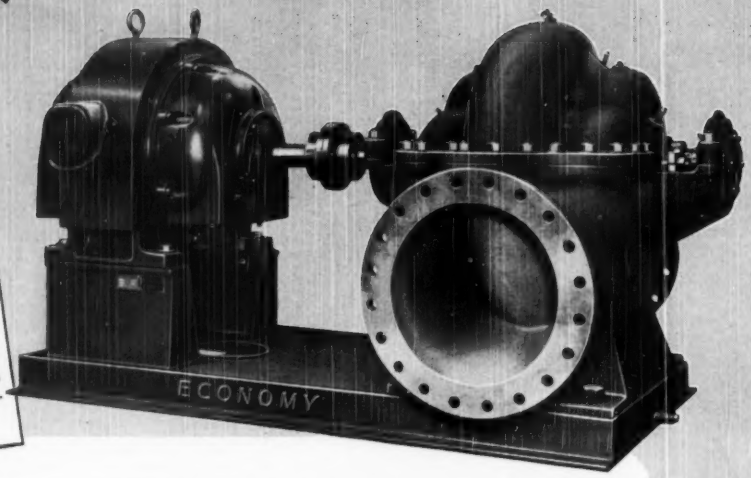
San Francisco 4 - 420 Chancery Bldg.

C-178

A DAY'S WORK FOR "OLD FAITHFUL"

...but just a 9 minute job for this ECONOMY PUMP

Erupting every 65.6 minutes, Old Faithful spouts a quarter-million gallons per day in an impressive display of Nature's "pumping" power. The same volume of water can be delivered in less than 9 minutes by an ECONOMY Double Suction Pump.



From 50 to 30,000 gallons per minute, there are more than 1500 ratings of this Economy Double Suction Pump . . . to meet your requirements for any capacity at heads to 300 feet. Designed for general purpose pumping of clear liquids at moderate heads, these single stage units are suited to general water supply or heavy mill service.

Sound hydraulic design give these Economy Pumps a broad, flat efficiency curve over a wide capacity range. Minimum maintenance is assured by sound engineering—based on such advantages as:

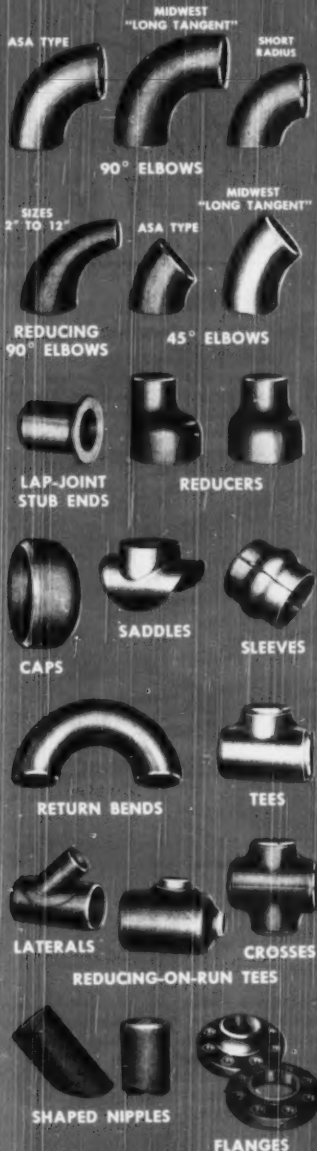
- **Easy removal of complete rotor without exposing bearings.**
- **No leakage between sleeve and shaft . . . shaft sleeves are sealed.**
- **Flanged wearing rings, "L" shaped, inward flow.**
- **Unusually effective water seals.**
- **Large wells for lubrication.**

If you wish full details, our Dept. BC-2, will gladly send you Catalog A-1147.

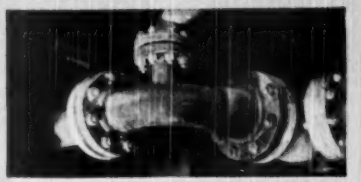
Economy Pumps Inc.

DIVISION OF HAMILTON-THOMAS CORP., HAMILTON, OHIO

MIDWEST WELDING FITTINGS
Improve Piping Designs and Reduce Costs



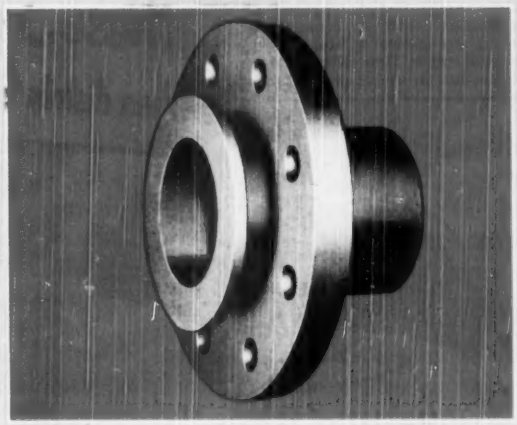
IN WELDED PIPING SYSTEMS



SAVE TIME and MONEY on EQUIPMENT CONNECTIONS

by using MIDWEST

LAP JOINT STUB ENDS



Substantial savings of time and money result if Midwest Lap Joint Stub Ends are used when making connections to valves, equipment or other flanged outlets in welded piping systems. They have important advantages over flanges welded to the pipe.

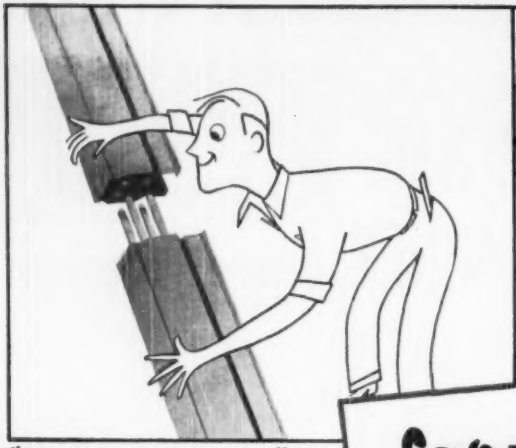
The swivel flange makes it unnecessary to line up the bolt holes before welding. Setting up is quick and simple because no special clamps or jigs are required to hold the face of the flange absolutely perpendicular to the axis of the pipe. Field crews report as high as 25% saving in erection time for making up a joint using Midwest Lap Joint Stub Ends in comparison with rigidly fixed flanges.

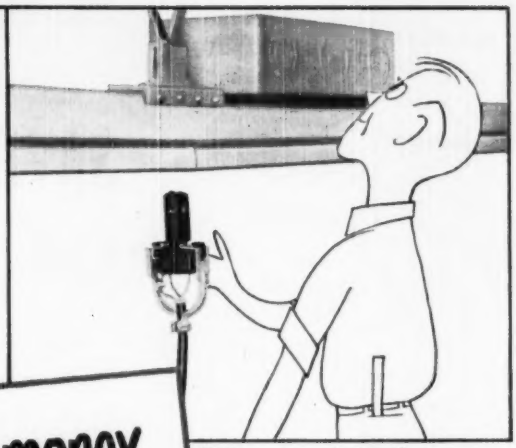
Midwest Welding Fittings improve piping—save money. Get in touch with the distributor near you.

3719

MIDWEST PIPING & SUPPLY COMPANY, Inc.

Main Offices: 1450 South Second Street, St. Louis (4), Mo.
***Sales Offices:* New York (7), 30 Church St.**
Chicago (3), 79 West Monroe St. • Los Angeles (33), 520 Anderson St. • Houston (2), 229 Shell Bldg. • Tulsa (3), 533 Mayo Bldg. • South Boston (27), 426 First St. • Distributors in Principal Cities.





Save money these 3 ways when distributing power

"Quick-install-ability"

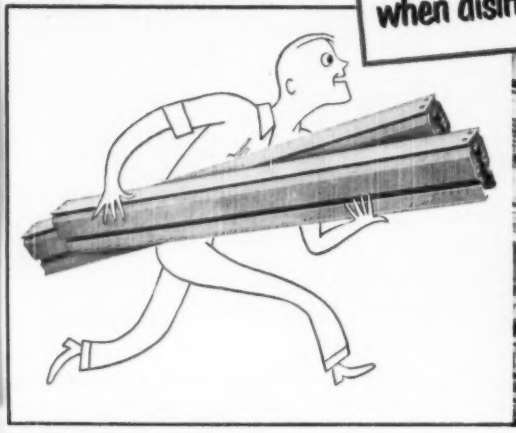
saves initial cost

LTG FLEX-A-POWER busways are pre-fabricated housings which are easily coupled in any arrangement and in runs of any required length. Time for installing is much less than for wiring and conduit.

"Plug-in-ability"

saves time relocating machines

Take-off plugs or trolley can be inserted anywhere (no drop-out section needed for trolley). You can add or relocate loads without rewiring expense and without long extensions.



"Take-apart-ability" saves material expense

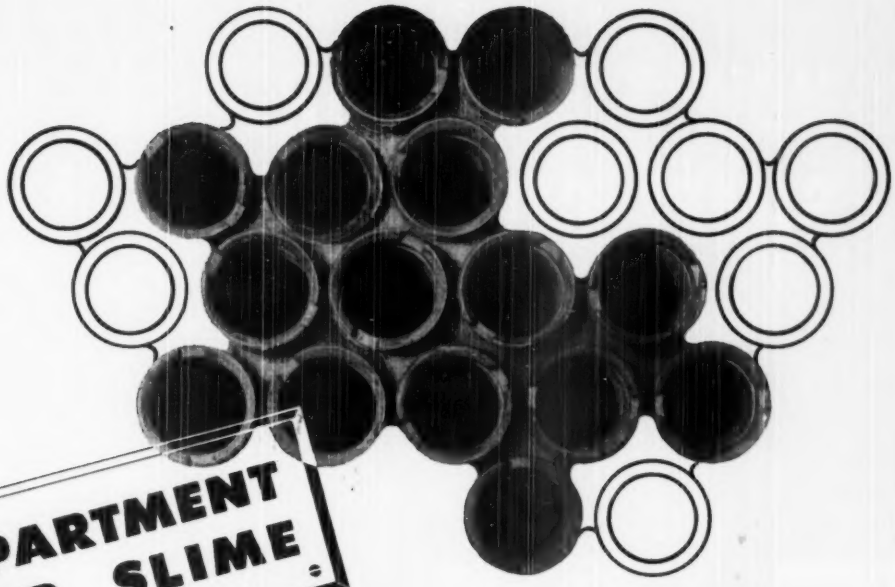
Whenever a *major* relocation of outlets is required, the entire FLEX-A-POWER system can be dismantled, removed to another location and re-installed with practically 100% re-use of materials.

Sealed Power Corp. saves with Flex-a-Power

LTG FLEX-A-POWER, one of six forms of FLEX-A-POWER for various services from main breakers to individual loads, is designed for light-duty lighting, small tools, appliances. Write for Bulletin TEC-3, THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Conn.

TRUMBULL (T) ELECTRIC

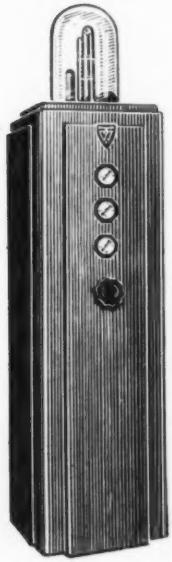
TRUMBULL'S TRAIN OF NEW PRODUCTS



APARTMENT FOR SLIME

With condenser tubes handling unchlorinated water, slime-forming bacteria never have to worry about a housing shortage. Instead, these bacteria move in, form their colonies, and the condenser tubes become apartments for slime. When this happens, the terminal log mean temperature difference rises, excess steam costs go up, and outage increases along with the labor bill for costly plug cleaning.

Chlorination, engineered by W&T and backed by 35 years' experience, has proven itself the effective answer to slime in condenser and heat exchanging equipment. It is effective because the Wallace & Tiernan De-Sliming Process attacks the cause of slime, bacteria, and "evicts" these unwanted "tenants" from their home in your equipment.



CD-32

Regardless of whether yours is an open or closed cooling system or whether you use shell and tube, trombone, or open box condensers, Wallace & Tiernan engineering plus time-tested W&T Chlorinators can put all the money-saving advantages of slime control by chlorination to work on your condensers or heat exchange equipment.

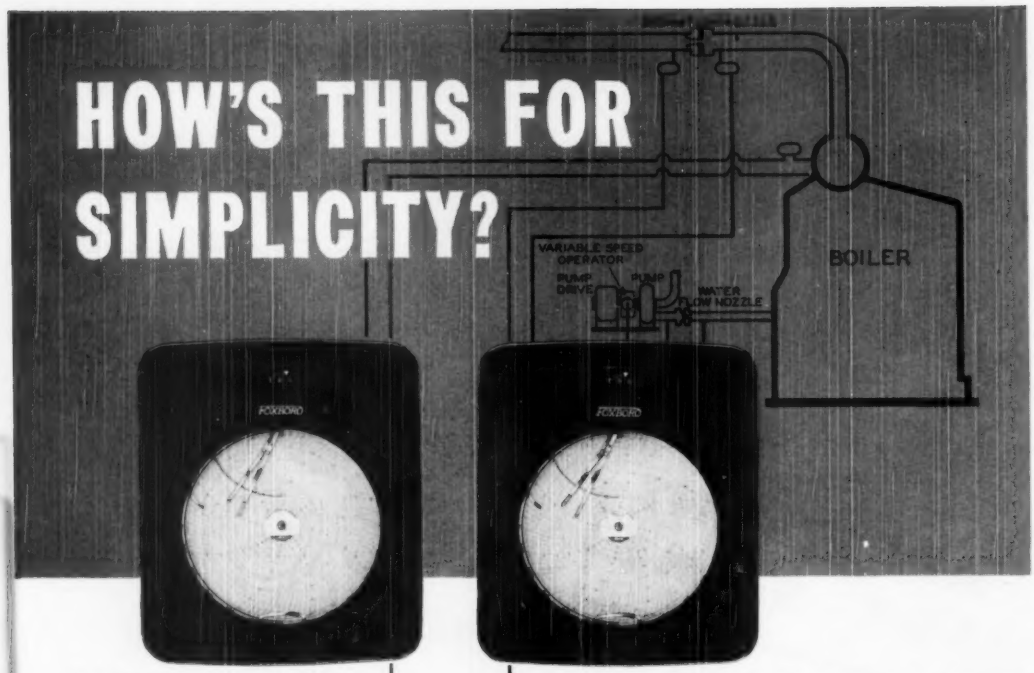
Write today for complete information.

WALLACE & TIERNAN PRODUCTS, INC.

CHLORINE AND CHEMICAL CONTROL EQUIPMENT

Belleville 9, New Jersey • Represented in Principal Cities

HOW'S THIS FOR SIMPLICITY?



M-40 Recording Liquid Level Controller

RESTRICTOR

M-40 Recording Steam Flow/Water Flow Pneumaticset Ratio Controller

3-Element Control for Boiler Feed Water with ONLY 2 INSTRUMENTS... NO AVERAGING RELAYS

Here's an opportunity to simplify boiler feed water control . . . and make it more dependable too. With this Foxboro system on a boiler of high steaming rate and low drum capacity, you get all the advantages of 3-element control, *plus* ratio-setting automatically adjusted by boiler water level. Ratio setting is undisturbed by the temporary effect of "swell" or "shrink" caused by sudden load changes.

This new standard of simplicity and dependability in boiler feed water control is made possible by two Foxboro Instruments, the M-40 Recording Steam Flow/Water Flow Pneumaticset Ratio Controller and the M-40 Recording Level Controller. The flexibility of Pneumaticset is outstanding . . . making the following combinations available almost instantly: (a) full automatic—steam flow/-water flow ratio controlled, with ratio set by level; (b) semi-automatic—steam flow/water flow ratio controlled, with ratio set by hand; (c) remote manual—feed water valve manually positioned from instrument.

Engineering data are available to help you check and compare this system. Write **The Foxboro Company, 74 Neponset Avenue, Foxboro, Mass., U. S. A.**

THESE M-40 FEATURES INSURE UNUSUAL RELIABILITY

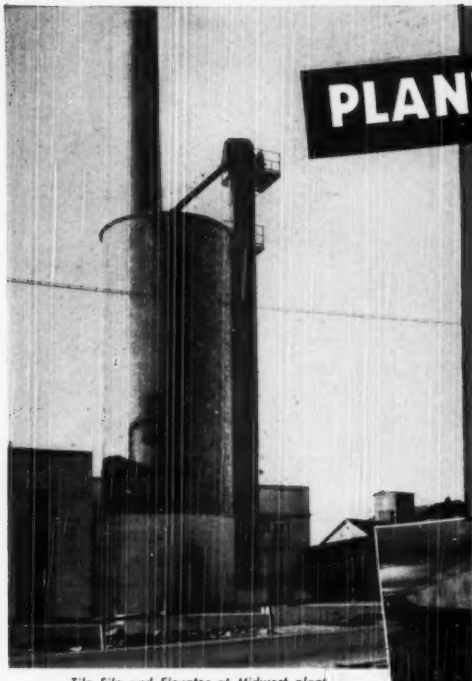
1. Unmatched ease and stability of adjustment **2.** Emergency-proofed—instrument can be dismounted without disturbing manual control panel **3.** Self-aligning ball linkage—pinch clip for easy removal **4.** Main and sub-assemblies interchangeable with those of other M-40 Controllers **5.** Precision-built, inside and out **6.** Proportional band setting, 0 to 200, either direct or reverse action made by turn of dial **7.** Wide range variable reset resistance, 0.1 to 50 minutes, without use of needle valves or lengths of capillary tubing

FOXBORO
REG. U. S. PAT. OFF.

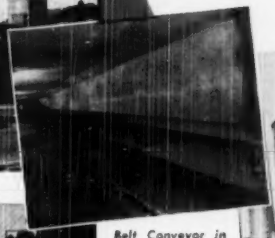
RECORDING · CONTROLLING · INDICATING
INSTRUMENTS

PLANTS THAT PROSPER

...cut powerhouse costs with FAIRFIELD coal and ash handling equipment!

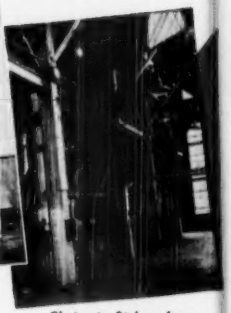


Tile Silo and Elevator at Midwest plant.

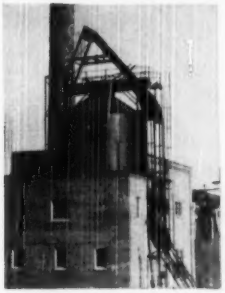


Belt Conveyor in Tunnel.

Large capacity Twin Silo System.



Chutes to Stokers from overhead bunker.



Skip Hoist and Cylindrical Bunker.

Tile Ash Bunker and Elevator.

Weigh Larry serving three boilers.

Screw Conveyor feeding stokers.

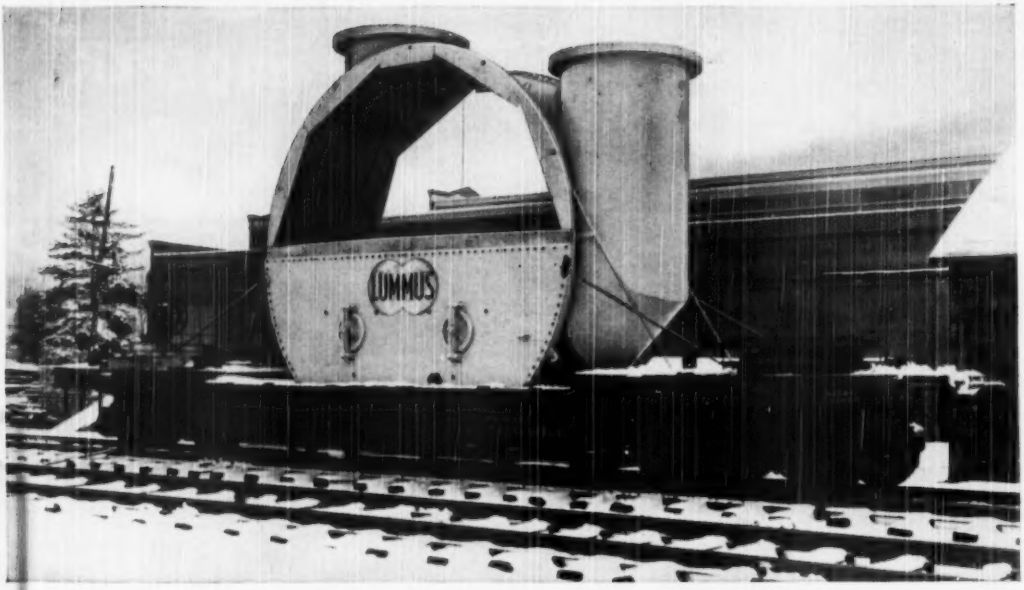
● Your powerhouse plays an important part in your production set-up. Keep efficiency at a high level . . . hold costs in line by modernizing your coal and ash handling system.

At no obligation to you, a Fairfield engineer will call and make a recommendation for improving your coal and ash handling operation. Fairfield engineers are thoroughly familiar with coal and ash systems for plants of any capacity. Thousands of installations in all parts of the country stand behind Fairfield's reputation for sound engineering and prompt erection. Write for an appointment with the Fairfield engineer in your area.

THE FAIRFIELD ENGINEERING COMPANY

Builders of Dependable Coal and Ash Handling Equipment

231 CHICAGO AVE. MARION, OHIO



A carload of design and fabrication know-how

Shown above is a 172″-diameter inlet-outlet water box with 54″-diameter flanged connections for a 52,500-sq.-ft. surface condenser. Inaccuracies in the water box cover connections, water-box-to-shell joint, or nozzle alignment could cause trouble and costly delay in installation. Stresses set up by distortions in connection could cause maintenance troubles later.

None of these troubles will happen.

The unit is of all-welded steel construction. The Lummus design was faithfully adhered to by top-grade welding and machining skill at Lummus' Honesdale (Pa.) plant, where the complete surface condenser was fabricated.

Thanks to such workmanship, all connections and joints are distortion-free—everything lines up accurately for trouble-free installation.

To make sure that you keep heat-transfer troubles out of your plant, make sure the job goes to Lummus.

THE LUMMUS COMPANY
Heat Exchanger Division
259 West 14th Street, New York 11, N. Y.

LUMMUS

Atlanta • Boston • Chicago • Cleveland
Detroit • Ft. Worth • Houston • Minneapolis • Pittsburgh
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Write for illustrated bulletin

We shall be glad to send you a copy of a publication containing 16 pages of design data, illustrations, and diagrams of heat transfer equipment. Ask for Bulletin M-303.

LOOK TO LUMMUS for Steam Surface Condensers • Evaporators • Feed Water Heaters • Boiler Blowdown Heat Exchangers Steam Jet Air Ejectors • Steam Jet Refrigeration • Barometric Condensers • Heat Exchangers • Process Condensers • Reboilers Steam Generators (Indirect Fired) • Fuel Oil Heaters • Lubricating Oil Coolers • Pipe Line Coolers • Jacket Water Coolers

Penflex HEART OF INDUSTRY'S LIFE LINES

FLEXIBILITY & DURABILITY FOR CONVEYING ... provides strength, withstands severest abrasion
HANDLES HOT MATERIALS ... unsurpassed for tar, asphalt, kerosene, chemicals and volatiles
TAKES SHAKES OUT OF AIR LINES ... on compressor, diesel exhausts and steam lines
TAMES A POWER THROB ... efficient, noisy vibration on diesel exhaust ... smoother power, cooler operation.
ARMED SECURITY FOR CABLES ... flexible protective coating to protect cables, instrument wires and lines

TORTURE-TESTED FOR SERVICE...PERFORMANCE-PROVED FLEXIBILITY—IT'S PENFLEX FOR LONG WEAR...EVERYWHERE

Whether it's on a diesel exhaust . . . a conveyor tube . . . or on air lines, Penflex tubing has proved itself in the power industry. Rugged . . . tough . . . and flexible, Penflex tubing is made to stand the most severe usage with the least wear.

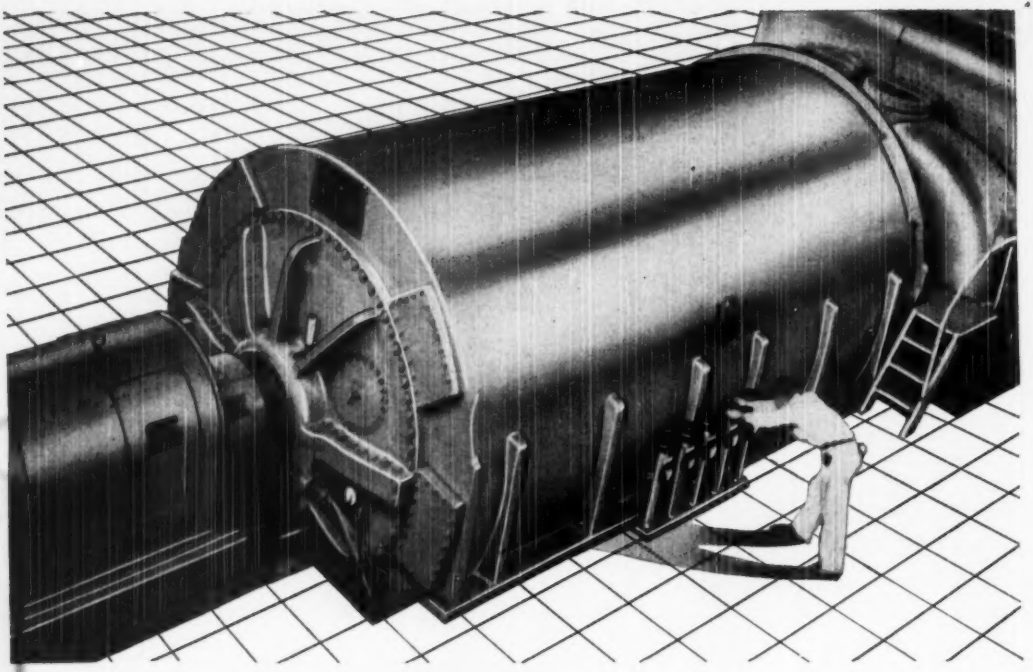
From ⅛" I.D. to 30" I.D. . . . bronze, galvanized or stainless steel, Penflex makes all types and sizes of flexible tubing and metal hose. And Penflex "Flexineering"—the science of applying flexible tubing to fit the particular need of the power industry—assures the right tube for each installation. When you require tubing or hose that is tight as a pipe, but flexible . . . safe at high temperatures . . . and free from metal fatigue, specify Penflex.

Penflex manufactures a complete line of four wall interlocked and seamless welded corrugated flexible tubing . . . plus automatic barrel fillers, rivet passers, accessories and fittings. To cut your "break-even point," write for your copy of "Flexineering At Work."

Pennsylvania Flexible Metallic Tubing Co., Inc.
7238 Powers Lane, Philadelphia 42, Penna.

Branch Sales Offices in

BOSTON • NEW YORK • CHICAGO • HOUSTON • CLEVELAND • LOS ANGELES



OHIO PUBLIC SERVICE *specifies* HONAN-CRANE

for Turbine Oil Purification in 5 plants

The Ohio Public Service Company has used Honan-Crane oil purification equipment continuously for seven years, now has Honan-Crane installed in five of its big Ohio generating stations which produce a total of 470,000 kilowatts.

Ohio Public Service first installed a Honan-Crane purifier in the Mahoningside station at Warren, Ohio, in December, 1941, and since that time has purchased additional purifiers for generating stations located at:

R. E. Burger Station	**Dilles Bottom, Ohio**	**230,000 kw**
Edgewater Station	**Lorain, Ohio**	**100,000 kw**
Mahoningside Sta.	**Warren, Ohio**	**82,000 kw**
Scioto Station	**Marion, Ohio**	**38,000 kw**
Melco Station	**Mansfield, Ohio**	**20,000 kw**

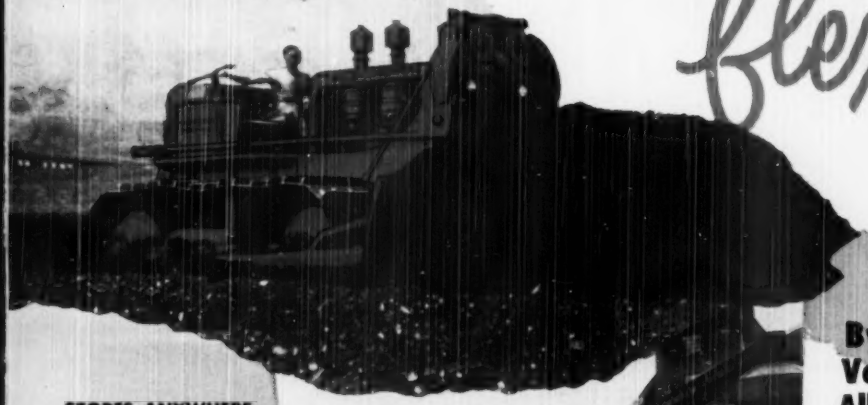
Using Cranite (specially processed fullers earth), stations are able to operate continuously with turbine oil held to safe, low neutralization and steam emulsion numbers. At the R. E. Burger station a variable schedule of purification has been established. Cellulose fibre is used as the regular filtering medium and is replaced by Cranite where the S. E. or neut numbers rise above specified limits. This more economical plan of purification is easy to accomplish because of the flexibility of Honan-Crane purifiers in accommodating either type of filtering media.

Honan-Crane oil purification equipment maintains Turbine oil in its original clean condition, removing oil contaminants as rapidly as they appear. Maximum turbine operating efficiency is possible and safe use life of oil extended because Honan-Crane purifiers give control over type of contamination that causes neutralization and S. E. numbers to rise beyond desired limits. For complete information on turbine oil purification, and Honan-Crane oil purifiers, write to 200 Superior Avenue, Lebanon, Indiana.

HONAN-CRANE CORPORATION
a subsidiary of
HOUDAILLE-HERSHEY CORPORATION

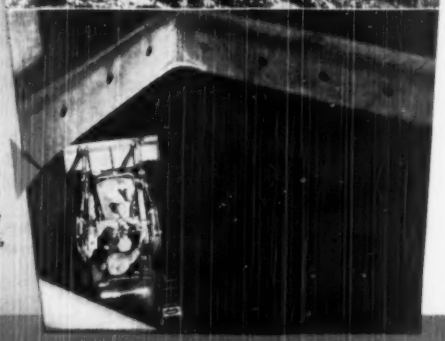
MAKE COAL HANDLING *flexible*

MOVES AND COMPACTS COAL — Allis-Chalmers HD-19 torque converter tractor with Gar Wood dozer moves coal up to 750 ft. from crusher chute out over storage pile at Georgia Power Co. plant near Macon, Ga. The 40,000-lb. tractor compacts the coal to eliminate danger of combustion.



STORES ANYWHERE, RECLAIMS AS NEEDED — Handling coal with four A-C Tractors and Gar Wood scrapers permits placing storage piles wherever there is available space around the Miami Fort plant of The Cincinnati Gas & Electric Co. Coal is hauled up to 1700 ft., spread in thin layers and compacted. The self-loading scrapers efficiently haul coal as needed to reclaiming hopper.

STOCKPILES — HD-5G Tracto-Shovel stockpiles coal as it is unloaded from railroad cars at Crown Cork and Seal Co., Baltimore, Md. Also used to load into trucks.



HELPS UNLOAD — Canada Cement Co., Montreal, uses HD-5G Tracto-Shovel with dozer to pull coal and cement from sides and ends of ship held into reach of crane bucket. Eliminates hand shoveling, speeds up unloading.

By Using Versatile Allis-Chalmers Tractors *you can*

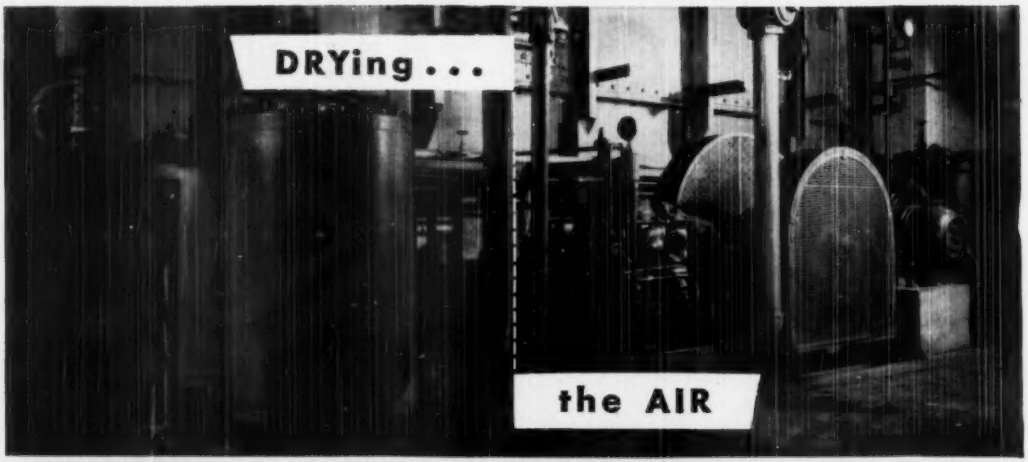
- ✓ Handle *all* of your coal storing and reclaiming — or supplement existing facilities.
- ✓ Add storage areas anywhere without installing costly conveyors, tracks, etc. — or abandon them without leaving money tied up in idle equipment.
- ✓ Speed up handling during rush periods by adding more tractor units.
- ✓ Quickly change storage system or methods... crawler tractors work free of rails and runways, make their own "roadway" anywhere!

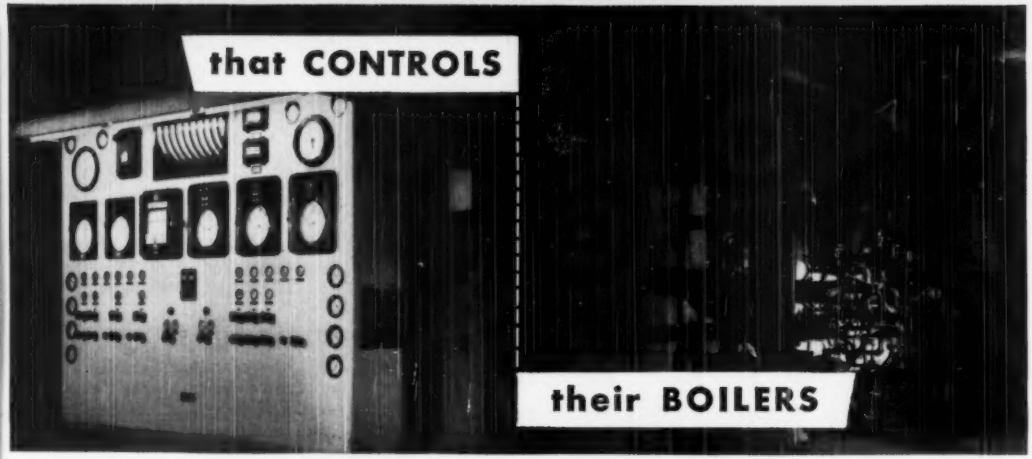
See your Allis-Chalmers dealer for a demonstration or write direct for complete information on modern coal handling with versatile Allis-Chalmers tractors.

Four Diesel-Powered Models — 11,000 to 40,000 lb.

ALLIS-CHALMERS

TRACTOR DIVISION • MILWAUKEE 1, U. S. A.





Boilers in Socony-Vacuum's power plant at Paulsboro, New Jersey, are air-controlled, providing a sensitive system which responds quickly and accurately to every demand for power. Instrument air is dried DRY by the Lectrodryer placed right alongside the compressor.

DRY air avoids the formation of rust or mud in piping, which would clog delicate instrument ports. It prevents freeze-ups where air lines run out of doors. DRY air helps keep controls functioning properly.

Lectrodryers are DRYing instrument air in power plants, oil refineries, food and chemical processing plants all over the world. Operating men say, "We couldn't be without them; they save us worry, time and money." They've proved their worth over many years.

For information on Lectrodryers for instrument air DRYing, or for any other service DRYing air, gases or organic liquids——write Pittsburgh Lectrodryer Corporation, 329 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Globe, Sydney.

LECTRODRYERS DRY
WITH ACTIVATED ALUMINAS

LECTRODRYER
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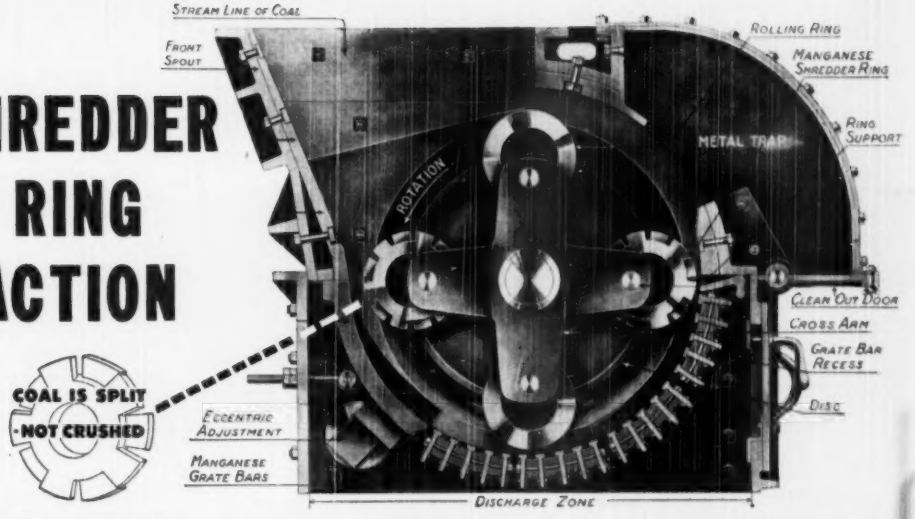
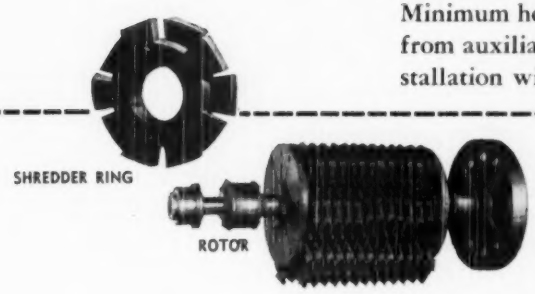
SHREDDER RING ACTION



the "WHY" of Uniform Coal Sizing with AMERICANS...

Efficient coal firing depends upon uniform sizing. That's why so many power plants use American Crushers—with exclusive Shredder Ring Action. Thrust outward against the coal by centrifugal force, the flexible rings maintain constant, controlled contact . . . to *split the coal—not crush it.* The result is a uniform product with controlled fines that assures a loose, uniform, *quickly responsive firebed*—without excessive ashpit drop or unnecessary CO_2.

Minimum headroom requirement and independence from auxiliary crushing permit easy, economical installation without extensive alterations.



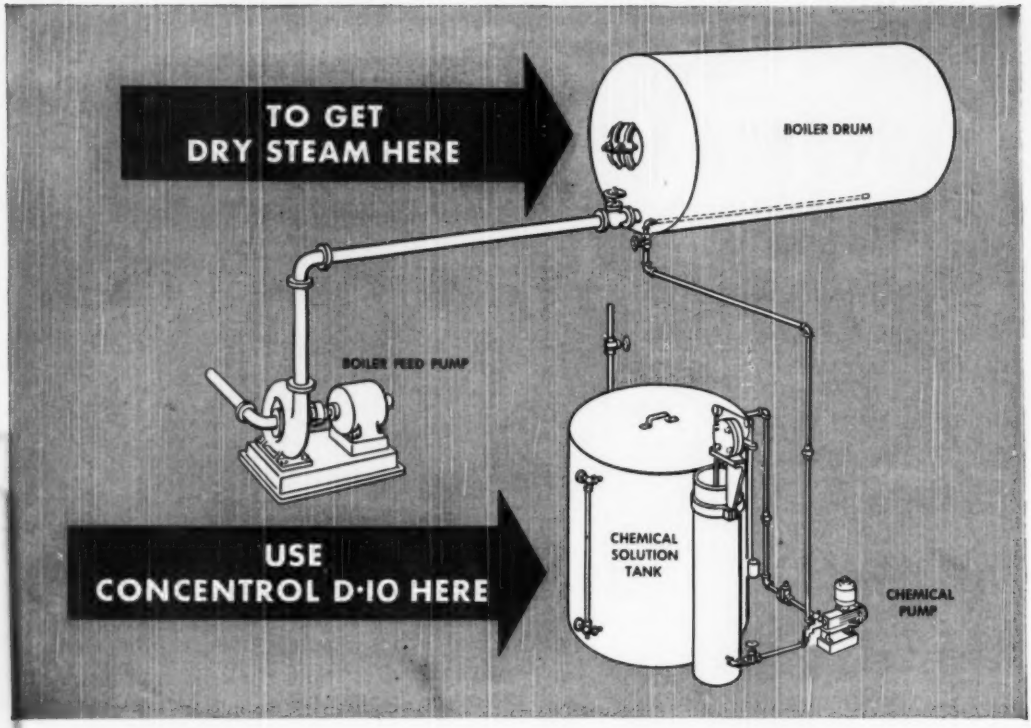
American Crusher's manganese steel shredder ring and rotor assembly—for rapid reduction at low, power-saving speeds. Each ring has 20 cutting edges . . . revolves on individual shaft, free to deflect from tramp iron without damage.

Send for your copy of "Crushing Coal for Less than 1¢ per Ton"

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1349 Macklind Ave.
St. Louis 10, Mo.



New Concentrol D-10 STOPS Foaming

FOAMING is one of the major causes of wet steam, an enemy of boiler performance. It may produce superheater deposits, failure of superheater tubes, deposits in steam traps and on turbine blades, damage to engine heads and many other operating difficulties. To help prevent them, Bird-Archer now offers Concentrol D-10, *a new development in foam control.*

HOW IT WORKS—This polyalkylene glycol compound sharply reduces steam bubble surface tension, thus permitting coalescence of the steam bubbles. This action eliminates carryover of boiler water due to foaming. As a result, you get dry steam.

HOW IT CONDITIONS SLUDGE — Concentrol D-10 comes in several different formulations, some of which contain a blend of selected tannins which condition boiler water sludge and suspended matter maintaining them in a fluid condition.

Concentrol D-10 is economical and can be applied continuously or by slug-feeding. It will prove effective in quantities from .05 to .2 lb. per 1,000 gallons of feedwater depending on individual conditions.

For full details on Concentrol D-10 and recommendations on your specific problem, consult your nearest Bird-Archer representative. Or write direct to Bird-Archer for further information.

BA 155

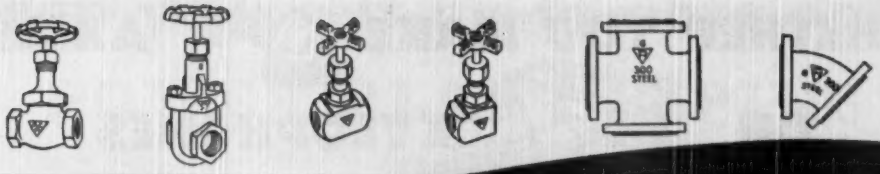
TYPICAL CONCENTROL D-10 "SUCCESS STORIES"

IN the highly alkaline waters of the Southwest, where blowdown rates approaching 25% formerly were necessary to stop foaming, the use of Concentrol D-10 has permitted non-foaming operation with boiler water alkalinities over 100 grains per gallon and concentrations of dissolved solids approaching nearly 500 grains per gal.

A mill in northern New York was forced to temporarily use a raw water of 20 grains hardness and containing 30 grains of chlorides. The use of Concentrol D-10 successfully prevented foaming with concentrations over 550 grains per gallon of dissolved solids.

BIRD·ARCHER
WATER TREATMENT

THE BIRD-ARCHER COMPANY, 400 MADISON AVE., NEW YORK 17, N. Y.
Philadelphia, Pennsylvania • Chicago, Illinois • Montreal, Canada
CALDERAS Y ACCESORIOS, S. A. AMSTERDAM 291, MEXICO, D. F.



R-P & C HEAVY-DUTY BRONZE GLOBE VALVE

FOR TOUGH THROTTLING CONDITIONS

500 BRINELL DISC AND SEAT

- **STEM** high tensile rolled bronze. Large diameter and long thread contact.
- **PACKING NUT** and gland follower of heavy bronze transmit even pressure onto packing.
- **STUFFING BOX** large and deep. Packed with formed rings of braided asbestos, lubricated and graphited. Can be repacked under pressure.
- **UNION NUT** heavy, rugged. Facilitates removal and replacement without danger of distorting body or threads.
- **BEVELED JOINT** permits tighter union between body and bonnet.
- **DISC LOCK-NUT** holds disc securely to end of stem.
- **FULL-PLUG DISC and SEAT RING** stainless steel of 500 Brinell—near diamond—hardness.
- **BODY P & C** High Test Bronze. Reinforcing ribs give added strength. Heavy end hexes with standard, full length threads.

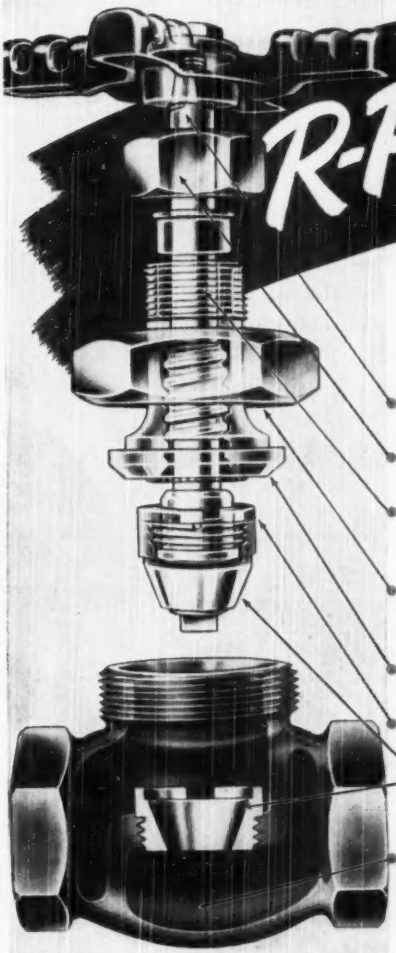
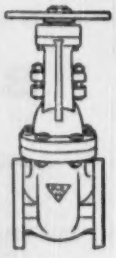


Fig. 531-P
350 lbs. Steam • 1000 lbs. OWG



Send **FOR THIS FOLDER** *which contains a detailed description of this valve. Ask for* **DH-116**

ACCO

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R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

READING-PRATT & CADY VALVES

WHETHER YOU MAKE AXLES

OR XYLOPHONES

AIR BY "Buffalo" HELPS YOU DO IT BETTER

NEED humidity control to halt rust? Looking for a cheaper way to convey materials? Want to remove corrosive gases from a continuous process? Striving for a better product and more of it? Better industrial relations? Lower accident rate? All these and many other air jobs are being done throughout industry by "Buffalo" Fans and Air Conditioning Units. "Buffalo" units will work quietly, day and night, in your plant — removing impurities, tempering, ventilating, cooling or heating — providing the atmosphere in which your product and your personnel can be at their best.

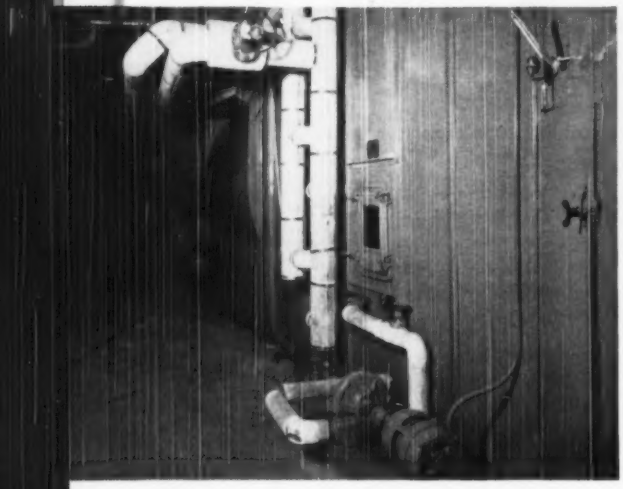
BUFFALO FORGE COMPANY

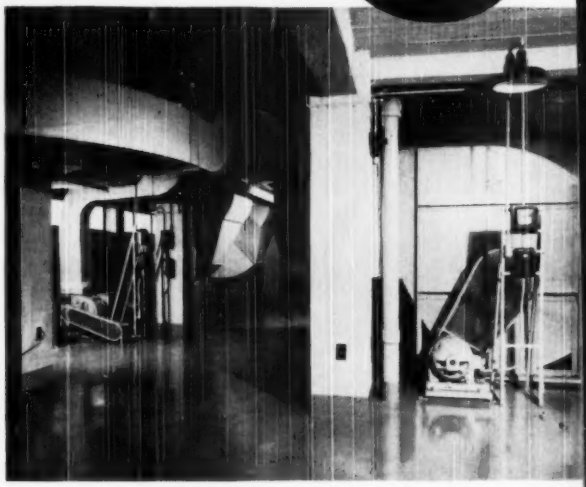
488 BROADWAY BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" FANS AND AIR CONDITIONING

Branch Offices in All Principal Cities





AIR CONDITIONING — OR SIMPLE VENTILATION?

"Buffalo" Air Conditioning Units can create and maintain literally any "climate" your plant requires—efficiently and at a very reasonable operating cost. Above, an air washer removes dust and humidifies a large plant. Many "Buffalo" Air Washers have been continuously on the job for over forty years.

A good, reliable fan like this "Buffalo" Limit-Load model might well provide all the cooling and general air comfort for your plant needs—when other air processing is not called for. Many "Buffalo" Fans have been on the job for forty, fifty and more years. The "Buffalo" line is COMPLETE—to suit any budget, any requirements.

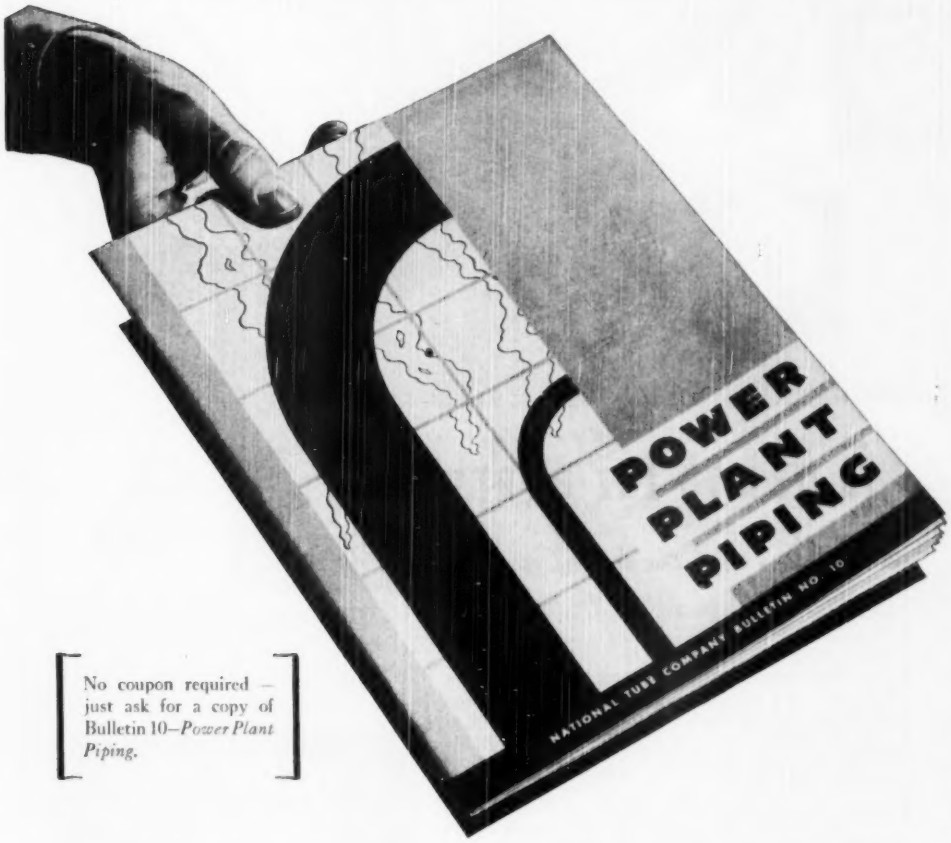
YOUR NEARBY "BUFFALO" ENGINEERING REPRESENTATIVE will give you recommendations — based on your problem and your budget — on turning your plant air to profitable use. He's a Graduate Engineer with 1-5 years of factory training. He's yours to call on, with no obligation.

Keep yourself up-to-date on POWER PLANT PIPING

THIS authoritative brochure should be in the hands of every man concerned with the piping requirements of a modern high-pressure, high-temperature steam station. For here is practical data and information that will greatly simplify your selection and use of power piping and will help you obtain greater efficiency and better results from its application.

In the 30-page "Technical Section" of this book you will find valuable information (some not hitherto published) on working stresses, creep properties, pipe bends; on weights, dimensions, properties of pipe and tubes and similar important data that you can use to excellent advantage.

Our Piping Specialists have cooperated in the construction of some of the Nation's most efficient light and power plants. Their experienced assistance is always at your service.



No coupon required — just ask for a copy of Bulletin 10—*Power Plant Piping.*

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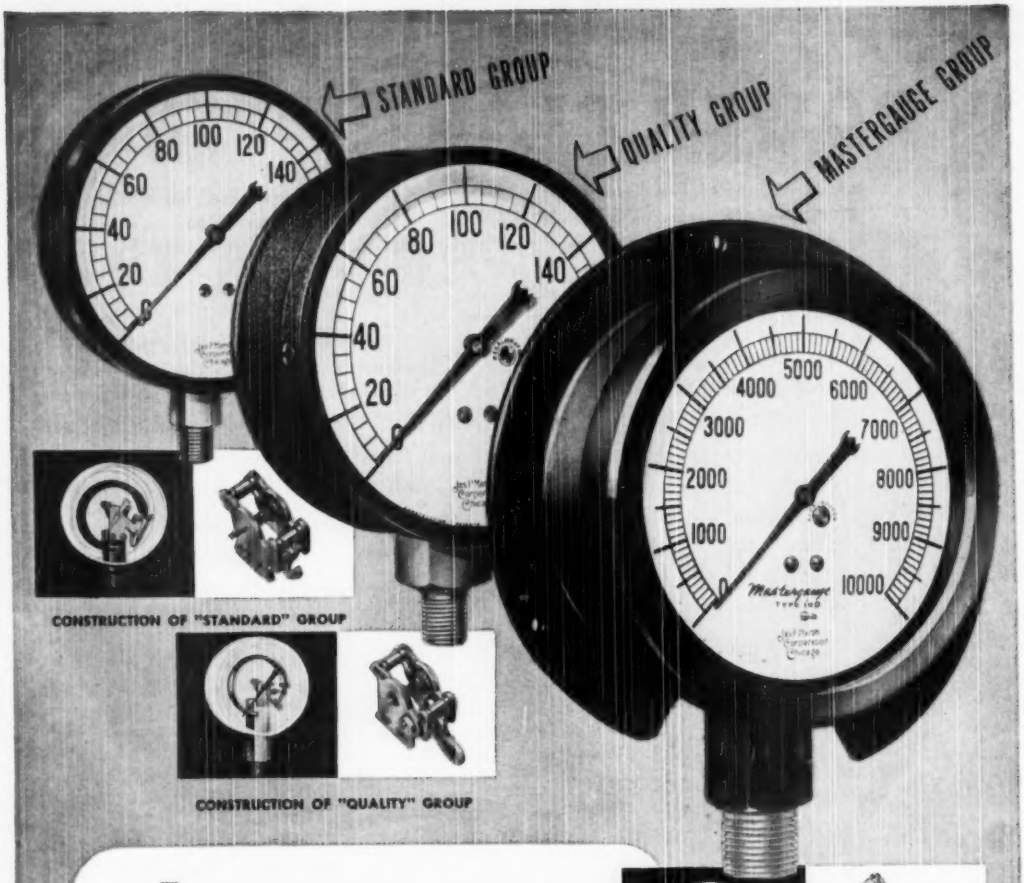
UNITED STATES STEEL



CONSTRUCTION OF "STANDARD" GROUP

CONSTRUCTION OF "QUALITY" GROUP

CONSTRUCTION OF "MASTERGAUGE" GROUP

A gauge for every need... *each the best of its kind*

Three basic groups of Marsh Gauges are shown here:

- The "Standard" group for the general run of gauge services.
- The "Quality" group for tougher service conditions.
- The "Mastergauge" group for the most extreme conditions.

While there is a considerable difference in the design and construction through these groups, the choice of a Marsh Gauge for a given application depends squarely upon the *service condition.*

This is because all Marsh Gauges — from lowest price to highest price — are high quality gauges. Each group or series contains the *best gauges of their kind.*

That is why you should use Marsh Gauges. Select the right Marsh Gauge and you use the most *economical* gauge for your requirement. We will help you select it.

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MARSH INSTRUMENT CO.

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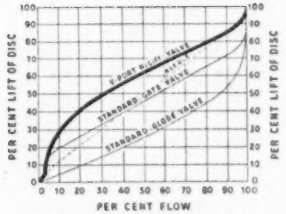
MARSH GAUGES

THE STANDARD OF ACCURACY



Flow characteristics of the Honeywell Hi-Lift Hand Control Valve far surpass those of conventional designs . . . offer favorable comparison to the precision of such diaphragm operated control valves as the Honeywell Series 700.

WORLD'S LARGEST ORGANIZATION FOR ADVANCED INSTRUMENTATION AND CONTROL
COMMERCIAL · RESIDENTIAL · INDUSTRIAL

THE Honeywell Hi-Lift Hand Control Valve is ideal for use where automatic regulation is not necessary or advisable. Designed to afford micrometer adjustment of flow, it contains an indicating scale to show percentage of stem travel to 1% and an inner valve capable of responding to such close correction. Inset illustration shows the simple and easy-to-read scale and the curve at left portrays the superior flow characteristics of the Hi-Lift over conventional valve designs.

The Honeywell Hi-Lift is available with v-port or parabolic discs . . . in sizes from ¼" to 12" . . . straight through or angle . . . for pressures up to 600 lbs. . . . with body of Bronze, High-Tensile Iron or Cast Steel . . . and with Bronze or Stainless Steel trim. Available, too, with electric motor for remote control applications.

Call in your local Honeywell engineer for detailed information about the Hi-Lift and such other Honeywell Process Control Specialties as: Transfer Valves, Liquid Level Devices, Cylindrical Plug Valves and the Honeywell Space-Saving Bypass.

Write, today, for a copy of Bulletin #242-1!

MINNEAPOLIS-HONEYWELL REGULATOR CO.
BELFIELD VALVE DIVISION
Philadelphia 44, Pa.

Offices in 77 principal cities of the United States, Canada and throughout the world

Honeywell — Process Control Specialties — Belfield

COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company "Bridgeport" *Headquarters for BRASS, BRONZE, and COPPER*

Use of Increased Water Velocity Helps Keep Condenser Tubes Clean

Large fouling organisms and certain slimes on condenser tube surfaces can be controlled by increased water velocities through the tubes. At water velocities over one to three feet per second most marine life cannot attach itself to tube surfaces. Higher velocity may also aid in preventing certain suspensions of industrial origin, wastes, etc. from adhering to the tube surface.

Dangers of Fouling

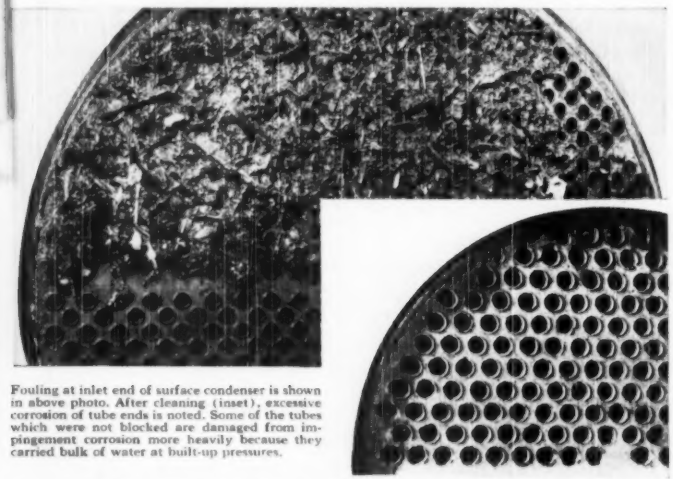
Where debris partially blocks off tubes for any length of time, the water velocity through the tubes affected may drop sufficiently to allow fouling organisms to attach themselves.

Once marine organisms have gained a foothold higher water velocities will not dislodge them.

Difficulty can be anticipated in condensers and heat exchangers operating at low water velocities, using water containing embryos of marine organisms. The organisms which attach themselves to condenser tubes vary considerably with localities.

The difficulties encountered due to organisms in tubes, on tube sheets and water boxes occur chiefly along three lines. First, blockage of condenser tubes markedly reduces the heat transfer of the condenser. Secondly, large masses of marine growth may restrict the flow of water so seriously that a high back pressure may damage pumps and associated piping. Third, during periods of shutdown incomplete removal of dead organisms will initiate corrosion pitting.

Micro-algae and bacterial slimes on tube surfaces during condenser shutdown may decompose with the liberation of ammonia. This has led to stress corrosion cracking of susceptible brasses. Since this can occur, it is of the utmost importance to dry out condensers promptly when they are to be shut down for a few or more weeks.



Fouling at inlet end of surface condenser is shown in above photo. After cleaning (inset), excessive corrosion of tube ends is noted. Some of the tubes which were not blocked are damaged from impingement corrosion more heavily because they carried bulk of water at built-up pressures.

Other Effects of High Velocities

The use of high water velocities is also beneficial in preventing clays, hydrated iron oxides, hydrated aluminum oxides and other materials from attaching themselves to the tube walls. Sometimes water velocities in excess of seven feet per second and approaching 10 or 12 feet per second, appear to be required to prevent the deposition of certain suspended materials from the water on to tube surfaces. For various reasons it is not always feasible to attain these high water velocities.

The use of water velocities in the order of five to seven or more feet per second requires the use of settling basins, screens or strainers in order to eliminate debris from the water before it reaches the condensers.

In some inland power plants water velocities as high as 10 feet per second have been used to keep condenser tubes clean and maintain high heat transfer rates. This has been possible where relatively little sand was suspended in the water, in the absence of debris and where the composition of the water was such that it was non-corrosive toward copper-base alloys.

Where water velocities in excess of six or seven feet per second are contemplated to keep tubes clean, it is advisable to proceed with caution since considerable damage can occur over a short period of time due to impingement corrosion at the inlet ends of condenser tubes or where the water flows around objects lodged in condenser tubes. In fact, even at six and seven feet per second, the finest and most corrosion resistant copper-base alloys are vulnerable to attack under such adverse conditions.

Bridgeport Tube Alloys

In general, Aluminum Brass, Cupro Nickel and Aluminum Bronze are more resistant to impingement corrosion than Admiralty condenser tubes. Bridgeport Laboratory is prepared to help in the selection of the alloy which will serve best under specific conditions.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN. • *ESTABLISHED 1865*

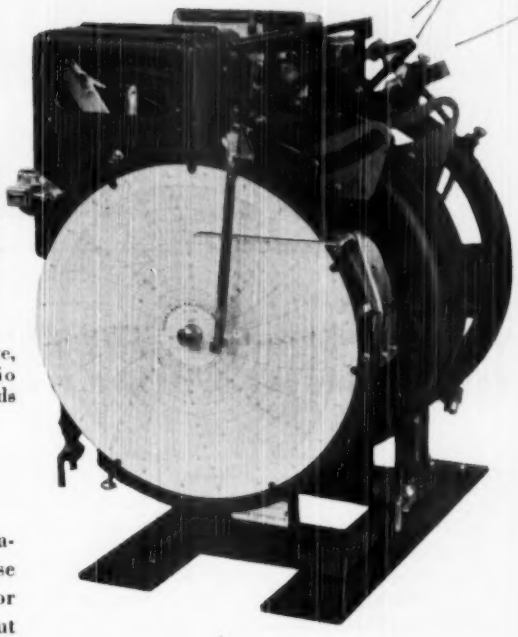
Mills at Bridgeport, Connecticut, and Indianapolis, Indiana • In Canada: Noranda Copper and Brass Limited, Montreal

HAGAN Ring Balance DUAL METERS

1 Require *no more panel space* than single meters.

2 Measure any two flows or flow and specific gravity recording them on the same chart for quick comparison. Either or both flows may be automatically totalized by built-in integrators.

3 By means of additive, subtractive or ratio linkage, combine records as desired.



In every power plant there are applications where some of the features of these versatile meters are highly important. For full information concerning them, fill out the coupon below, or write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
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Please send me your bulletin "Hagan Ring Balance Dual Meters."

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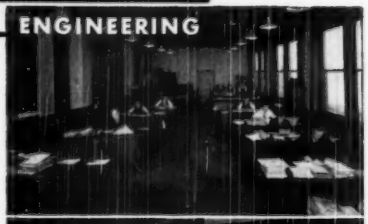
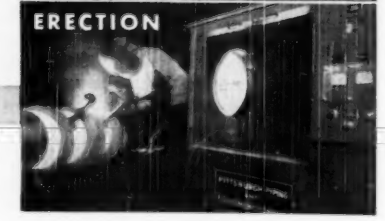
P1

THE FIRST STEP
is
All You Need Take





WHEN YOU TURN THE COMPLETE POWER PIPING JOB OVER TO P. P. & E.

Just take one step when you need new power piping. Turn the complete job over to P.P.&E. By placing this responsibility in our hands you obtain the advantages of a distinctive engineering technique, complete shop fabrication facilities, specialized metallurgical control methods complete with model testing, and skill in meeting and solving present-day field erection problems. Furthermore, you are relieved of detail . . . and utilize to the utmost the knowledge we have accumulated through almost a half century of practical experience in this field. Ask our nearest representative for further information.

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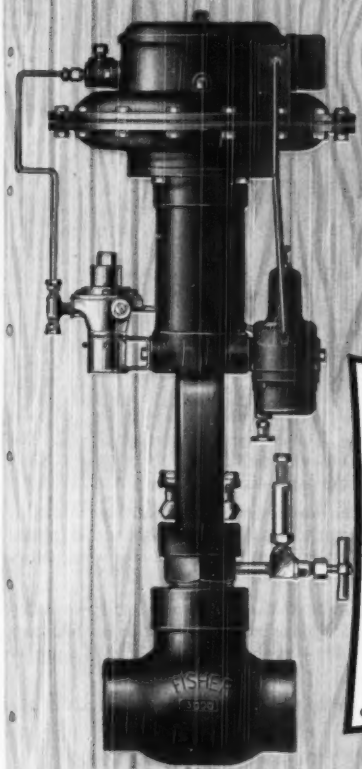
"PACKAGED"

REGULATORS AND CONTROL VALVES



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ONE CONNECTION

HOOK-UP

Integrally mounted Wizard Pilot-operated pressure controller, requiring only one field connection.

"FACTORY PIPED"

DIAPHRAGM MOTOR VALVE WITH AIR-SET AND POSITIONER

Only 2 connections to make—from operating medium supply and controller.

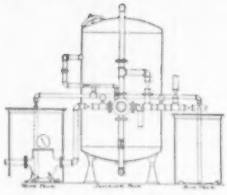
Advantageous for installations in industrial process plants, gas pipe-line regulating stations and oil field applications. Saves time and expense ordinarily involved in handling usual piping accessories and piping details. Essential parts cannot be misplaced or incorrectly applied.

FISHER GOVERNOR CO.

MARSHALLTOWN, IOWA

ILLCO-WAY DE-IONIZER TREATS 300 GPM OF BOILER-FEED MAKE-UP WATER AT THE DOW CHEMICAL PLANT, FREEPORT, TEXAS

Dissolved solids and silica removed by ionXchange... CO_2 removed by degasification



ILLCO-TEMP SOFTENER

...for removal of residual hardness from the effluent of hot or cold lime-soda units—*without chemical after-treatment.* Chemical savings from this alone will normally pay for equipment in less than 2 years. Reduction of effluent from lime-soda units to "zero" hardness produces real operating economies. Scale-forming salts are eliminated. No after-precipitation in the lines, pumps, pre-heaters, or the boilers themselves.

Softener is easily added to hot lime-soda water softener. Unit operates economically and continuously at temperatures as high as 250° F or higher . . . on waters having a pH as high as 10.5.

The De-ionizing unit shown above treats 300 gpm of water used as make-up in the power plant of The Dow Chemical Company, Texas Division, Freeport, Texas. The power plant operates seven Riley boilers, each at 250,000 lb. per hr., at 400 lb. 750°. These gas and oil fired steam generating units serve six turbo generators.

According to the plant's chief engineer, the most significant advantage resulting from the installation of this De-ionizing unit was the improvement of steam quality . . . "which has resulted in a marked increase in the duration of satisfactory operation of the turbine units between washing periods."

Figures given in the chief engineer's report indicate that the equipment has enabled the plant to reduce phosphate additions by approximately 60%, further assisting in the reduction of the total solids within the boiler while still maintaining a proper phosphate ratio.

Below is an analysis of the raw water prior to treatment and an analysis of the final treated De-ionized water.

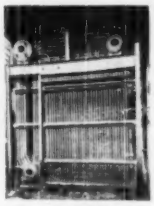
Raw water analysis		De-ionized water analysis	
Ca -12 ppm	HCO_3 -126 ppm	Total hardness as $CaCO_3$	-0.5 ppm
Mg -14 ppm	Cl -164 ppm	Na	-6.0 ppm
Na -188 ppm	SO_4 -140 ppm	CO_2	-2.5 ppm
pH -9.0	SiO_2 -8.5 ppm	SiO_2	-0.2 ppm

Write for full descriptive literature covering Illco-Way De-ionizing equipment.

ILLCO-WAY

DE-IONIZING
DE-ALKALIZING
SOFTENING

ILLINOIS WATER TREATMENT CO., 853-2 Cedar St., Rockford, Illinois · 7310-NN-2 Empire State Bldg., New York City

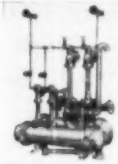


BOILERS

DEAERATORS

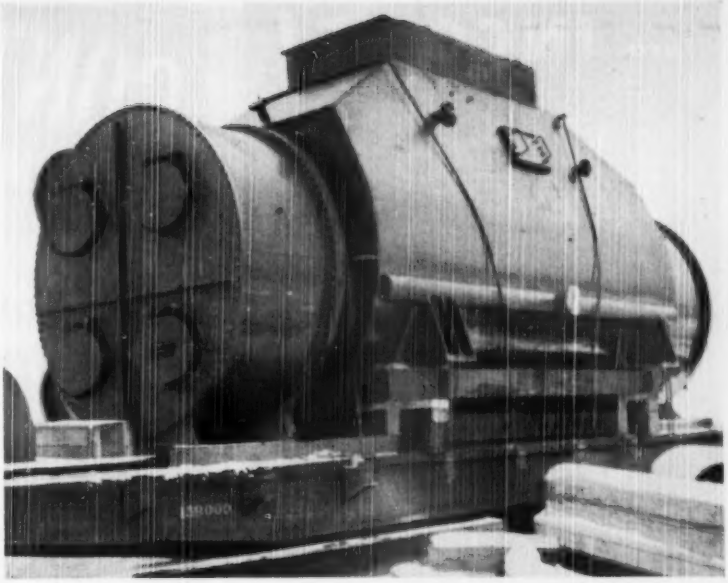
CLOSED HEATERS

EVAPORATORS



STEAM JET
AIR EJECTORS

Above
Other Equipment in the CONSECO line



A 12,000 sq. ft. CONSECO CONDENSER

. . on its way to join 2 duplicate units already in service

The original installation of CONSECO CONDENSERS in this plant was so satisfactory that, when expansion in capacity became necessary, a third CONSECO unit was ordered.

Plant: Dairyland Cooperative, Alma, Winconsin (REA).

Consulting Engineers: Verne E. Alden Co., Chicago, Ill.

Generators: 3-15000 KW Turbines at .8 PF operating at 22,500 KVA constantly.

Condensers: 3-12000 sq. ft.; 2622 tubes, 7/8" O.D., 18 gauge; effective tube length 20'; tubes of Arsenical Admiralty.

Avail yourselves of Conseco's long, successful, specialized experience in the design and building of steam condensers, H.P. feed water heaters, deaerating feed water heaters, evaporators, steam jet air ejectors and any other type of heat exchanger.

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CONSECO **Condenser Service & Engineering Co.**
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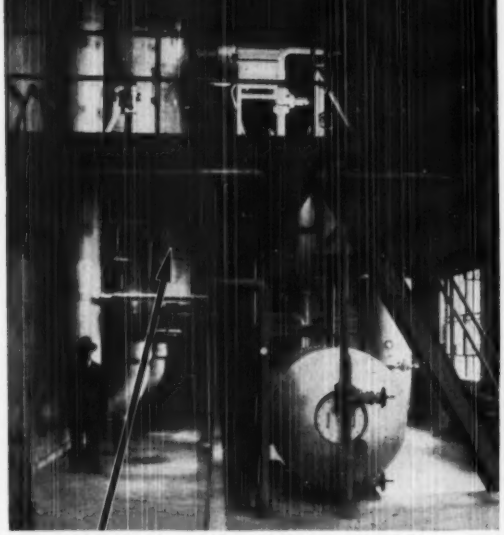

MAXIM HEAT RECOVERY SILENCERS

produce steam for plant heating and for sale to nearby customers

Close-up view showing two BVS Heat Recovery Silencers at New Prague; accumulator tank in left foreground.

The municipal power plant at New Prague, Minnesota makes good use of Maxim Heat Recovery Silencers. Waste exhaust heat that would normally go up the flue is used as it passes through the heat recovery silencers to produce usable and salable steam. The steam in this case is used for heating the plant itself, and surplus is sold for heating nearby homes, stores, and a factory.

Thus the New Prague municipal plant achieves effective and very necessary silencing of exhaust noise, but makes this silencing pay for itself many times over.

More and more industrial users, long accustomed to the necessity of effective silencing, are now realizing the profit possibilities of installing heat recovery silencers to produce steam for heating or processing operations, and without any extra fuel cost.

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☐ Heat Recovery ☐ Intake
☐ Exhaust ☐ Spark Arrestors

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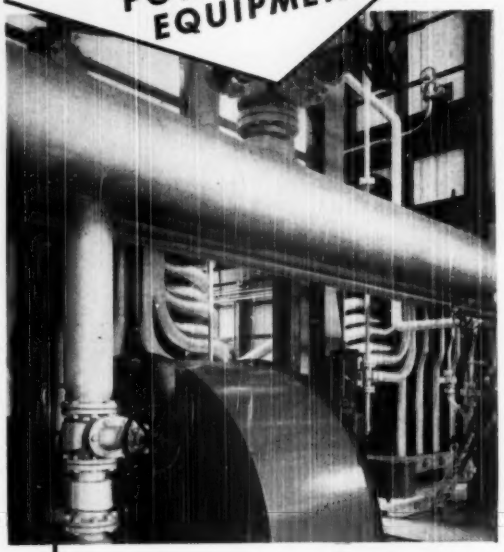

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There is a Wright Field Engineer near you who will be glad to help you with your scale and corrosion problems. No obligation.

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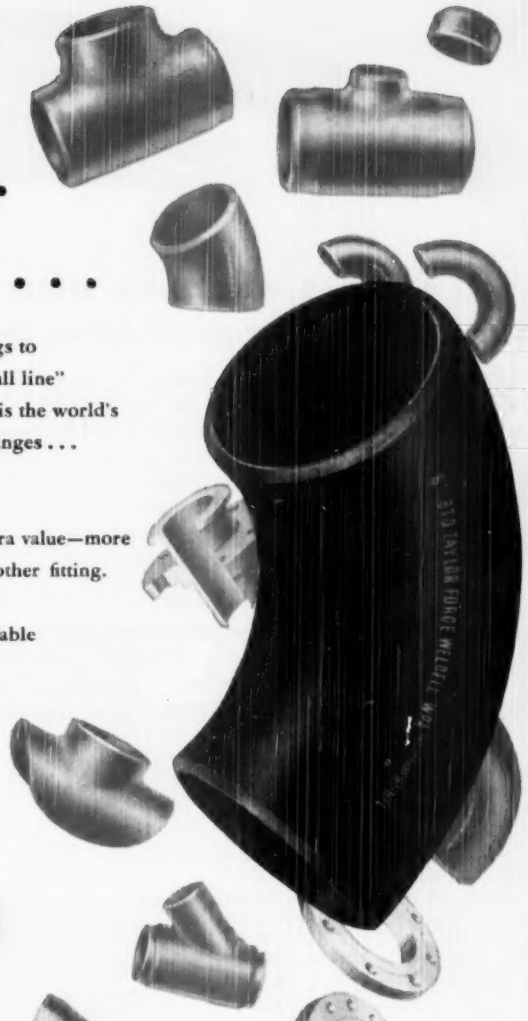

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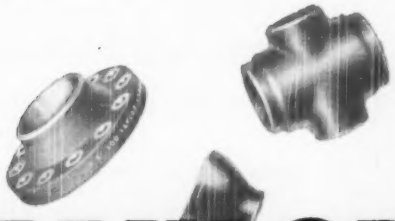

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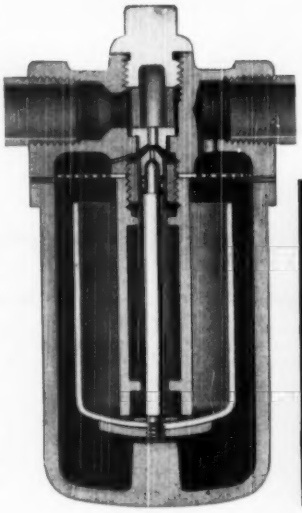

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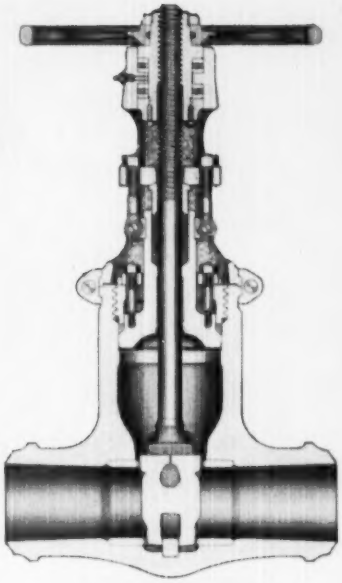

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600, 900, and 1500-Pound

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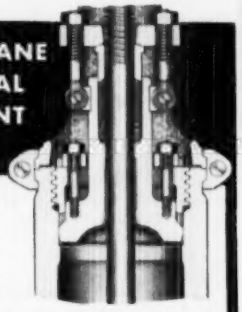
HOW THE CRANE PRESSURE-SEAL BONNET JOINT OPERATES



Bonnet joint is inside the valve . . . sealed with a wedge-shaped seal ring. Internal fluid pressure acting upon entire underside of bonnet *reacts* upon smaller contact area of seal ring. Leakage is impossible because sealing pressure is always greater than pressure of line fluids. The higher the internal pressure, the greater the sealing pressure.

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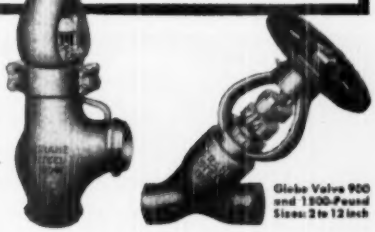
Sizes: 6 to 12 inch



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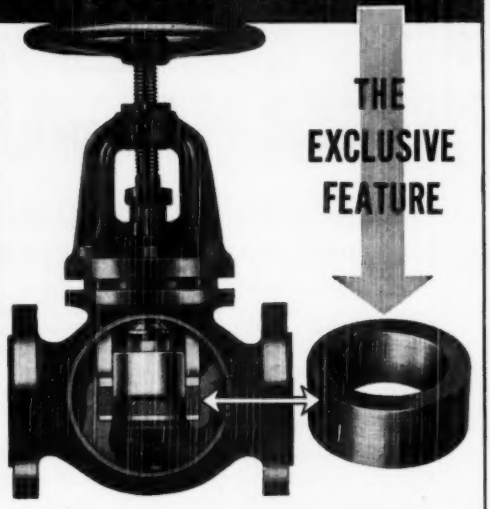

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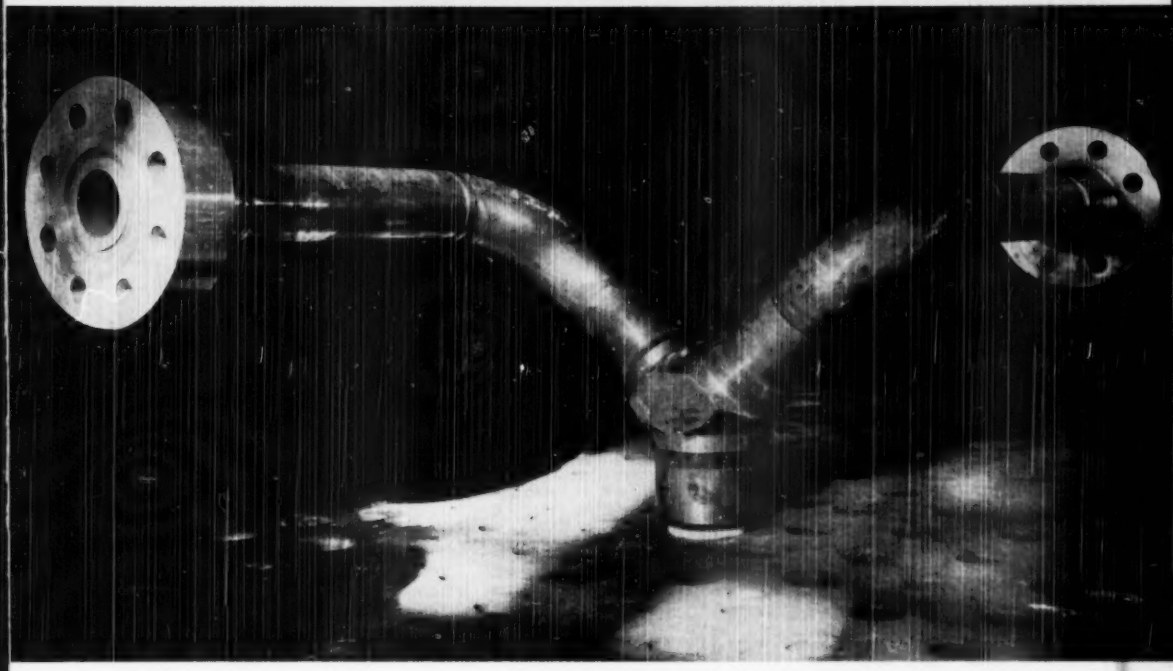

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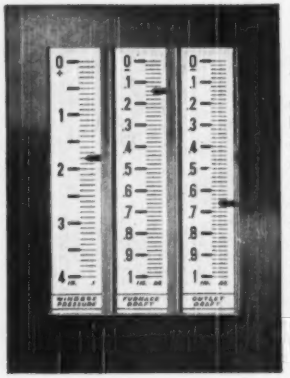

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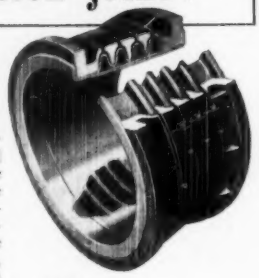

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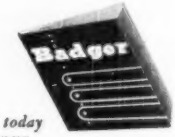

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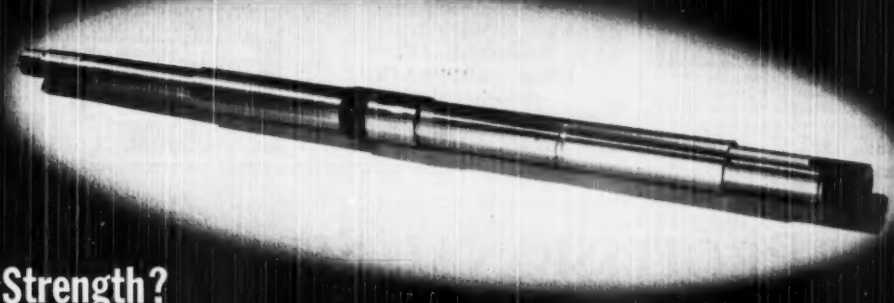

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3

Pliseal Boiler-Wall Coating

Coat the outside of brick settings with Pliseal. It saves fuel by sealing the joints and cracks in the brickwork, preventing the infiltration of cold air into the furnace. It waterproofs the setting and preserves the brickwork. Easily applied with a trowel. Will not crack, peel, or blister. Pays for itself in a few months with increased efficiency.

Packed in 5, 30, and 55-gal. drums. 5 gals. covers 60 sq. ft. ⅛ in. thick.

4

Hyrate and Demon Cements

These high-temperature cements are unexcelled for pointing up cracks and minor repairs. Hyrate is a heat-setting cement in dry, powdered form for extreme combustion conditions. Packed in 100-lb. bags.

Demon Air-Set is a popular cement in moist, plastic form ready for immediate use; easy to use; sets cold on exposure to air, forming an exceptionally strong bond. Packed in 50-lb. pails and 100, 200, and 500-lb. drums.

PLIBRICO JOINTLESS FIREBRICK CO., 1804 Kingsbury St., Chicago 14, Ill.

Please send bulletins on:

- ☐ Plibrico Jointless Firebrick
- ☐ Plicast Castable Refractories
- ☐ Pliseal Boiler-Wall Coating
- ☐ Hyrate and Demon Cements

Firm_____

Name_____ **Title**_____

Address_____

No. Boilers_____ **H.P.**_____ **Type**_____

Repairs needed when?_____

SEARCHLIGHT SECTION

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

UNDISPLAYED RATE
(Not available for equipment advertising)
$1.20 a line, minimum 4 lines. To figure advance payment, count 5 average words as a line.
INDIVIDUAL EMPLOYMENT WANTED undisplayed advertising rate is one-half of rate, payable in advance.
PROPOSALS, $1.20 a line an insertion.

INFORMATION
BOX NUMBERS in care of any of our New York, Chicago or San Francisco offices count 1 line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED RATE:
The advertising rate is $10.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns — 30 inches—to a page.

NEW ADVERTISEMENTS received by February 7th will appear in the March issue, subject to limitation of space available.

ELECTRICAL ENGINEER
Fox River Valley (Wis.) paper mill wants electrical engineer experienced in all phases of maintenance and layout. Give complete personal and business history in letter of application. Write
P-1907, POWER
520 N. Michigan Ave., Chicago 11, Ill.

SALES REPRESENTATIVE
Nationally known Missouri manufacturer of REFRACTORIES offers a sales position selling high temperature mortars, plastic fire brick, castables, etc. To be considered EXPERIENCE is absolutely necessary. Willing to travel. Good starting salary, opportunity for advancement.
SW-2032, POWER
330 W. 42 St., New York 18, N. Y.

Engineers — Executives — Technical Men
Salaried Positions, $4,000 to $30,000
This Confidential service for men who desire a new connection, will develop and conduct preliminary negotiations without risk to present position. Send name and address for details.
TOMSETT ASSOCIATES
1205-2 Berger Bldg., Pittsburgh 19, Pa.

REPLIES (Box No.):
Address to office nearest you
NEW YORK: 330 W. 42nd St. (18)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

WANTED CHIEF ENGINEER: Public utility in western Ohio has immediate opening for chief operating engineer of steam-electric plant. Technical graduate or equivalent with experience in operation and maintenance of modern steam plant equipment. Submit record of training and experience and if interesting to us personal interview at our expense will be arranged. All replies held in strict confidence. Address P-1984, Power.

GRADUATE MECHANICAL Engineer to assist superintendent of production for public utility located in Ohio. Minimum experience of three years in steam plant operation required. Age 30-35, preferred. Permanent position with good future for qualified man. Give full outline education, work and personal references, salary expected. All replies confidential. P-1985, Power.

GRADUATE MECHANICAL Engineer with several years sales experience to travel entire country and Canada calling on agents for manufacturer located in East, manufacturing Steam Traps, Valves, Separators, etc. Experience in heating and steam specialty field preferable. Give age, qualifications, experience, etc., as well as compensation expected. P-1852, Power.

SELLING OPPORTUNITY OFFERED

SALES REPRESENTATIVE: A nationally-known piping fabricator and erecting contractor offers an unusual opportunity for one with substantial sales experience in piping or kindred lines, to cover the entire South. Position requires contacts in the oil refining, chemical and power plant fields, and offers unlimited possibilities for development of the territory. Forward detailed account of experience giving sales record, educational background, and earnings expectancy. All replies will be held in strict confidence. SW-1939, Power.

SEND your TRANSFORMERS to
ELECTRIC SERVICE CO., INC.

A financially responsible organization specializing in buying, selling, repairing, rewinding and redesigning transformers only.

Experienced personnel assures you first class workmanship and complete satisfaction.

Every transformer guaranteed for one year

The Electric Service Co., Inc.
"AMERICA'S USED TRANSFORMER CLEARING HOUSE"
MARIEMONT Since 1912 CINCINNATI 27, OHIO

EMPLOYMENT SERVICE

SALARIED POSITIONS $3,500-$35,000. If you are considering a new connection communicate with the undersigned. We offer the original personal employment service (40 years recognized standing and reputation). The procedure, of highest ethical standards, is individualized to your personal requirements and develops overtures without initiative on your part. Your identity covered and present position protected. Send only name and address for details. R. W. Bixby, Inc., 270 Dun Bldg., Buffalo 2, N. Y.

SALARIED PERSONNEL $3,000-$25,000. This confidential service established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited, Jira Thayer Jennings, Dept. G, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

MECH'L ENG'R—50—Desires permanent connection at plant eng'g, preferably Phila. area. Experienced design, studies, purchasing, construction and operation of power installations. PW-1793, Power.

INDUSTRIAL-UTILITY Power Plant operator wishes position as assistant engineer in small plant. 7 yrs. high pressure turbo-plant. 7 yrs. high pressure turbo-electric and boiler experience as watch engineer in charge of boilers. Also some refrigeration and diesel. Excellent education and practical experience. 29 yrs. old; married. Will relocate. PW-1905, Power.

M.E. SR. Power Plants, industrial; 20 yrs. Oper. Maint. Mngmt., Supt., seeks permanent connection anywhere. PW-1970, Power.

MECHANICAL ENGINEER, 32, experienced generally in design, estimating, and construction, material handling, piping, plumbing, heating, structural, specialized machinery. Supervisory background, seeking responsible position. Present earnings over $5000. Reply PW-2001, Power.

MECHANICAL, ASS'T Chief Engineer or Chief Draftsman: 37—ASME, BCHE, PE. Diversified design and engineering experience in construction, utilities and process industries. Past 3 yrs. in high executive capacity. PW-1955, Power.

OPERATION MAINTENANCE Construction Engineer—20 years experience, with intimate knowledge of all Power Station equipment. Construction and operation covering pressures to 1500 psi, temperatures to 1000° F. Good knowledge of automatic controls and all types of Firing and Elec. Generation. Also union agreements and contracts. Let me help rebuild, modernize and operate your plant. Midwest preferred. PW-2031, Power.

POSITION WANTED

ENGINEER P.E. Wide experience design of Public Utility and industrial power plants, both mechanical and electrical. Heat balance, piping, coal and ash handling, power and light distribution. Calculations, specifications, requisitions and supervision. PW-8064, Power.

SELLING OPPORTUNITY WANTED

NEW YORK Representatives Available. Organization with six sales engineers needs one additional product, for all or part of Southern and Central New York State and New Jersey. Now selling steam traps, control valves, combustion test instruments, etc., to industrials, utilities and institutions. Regulators or other steam specialties preferred. RA-1260, Power.

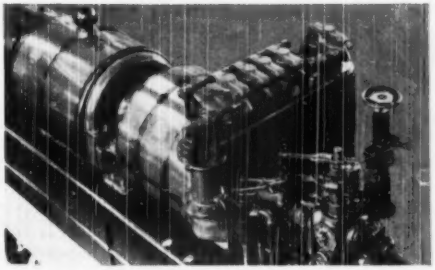
British manufacturers and patentees of the "Autolec" Electrode Type Steam Raisers and Hot Water Boilers, ideal for all users of steam, wish to contact a manufacturer in America interested in taking over the manufacturing rights on a royalty basis.

Full details supplied on request

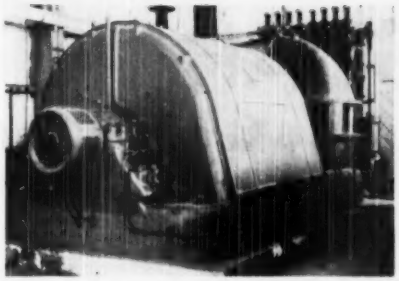
G.W.B. ELECTRIC FURNACES LTD.
Dibdale Works, Dudley, Worcestershire.

When Answering
BOX NUMBERS...
to expedite the handling of your correspondence and avoid confusion, please do not address a single reply to more than one individual box number. Be sure to address separate replies for each advertisement.

Turbo-Generators, Diesel Power, Boilers Our Specialties



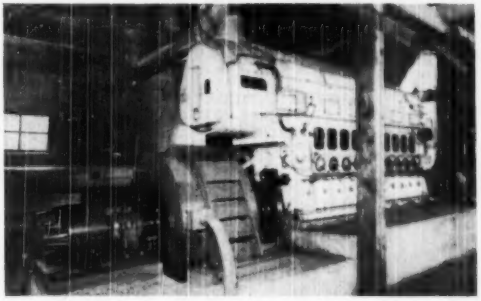
1500-KW., G.E.. Non-cond.. 15/50# Back P. 150/260-PSI. Very Modern: No. 1 Cond.



6250-KVA., G. E. Cond.. 200#-psi.. 7000-sq. ft. Cond. Complete Unit. No. 1 Condition.

DIESEL POWER

We Carry a LARGE STOCK FROM 100 to 1500-KW. Capacity



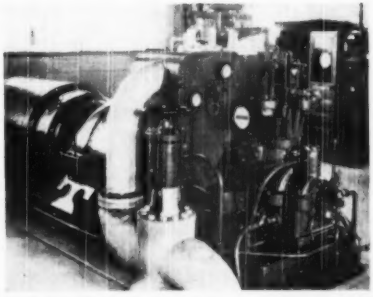
1600-HP., O.P.. F. Morse Diesel Engine. Model 38D8 1/8 with 1250-KVA.. NEW Elliott Generator. 720-RPM.. 2300/4160-V. Under Erection. Location on request.

NEW & USED

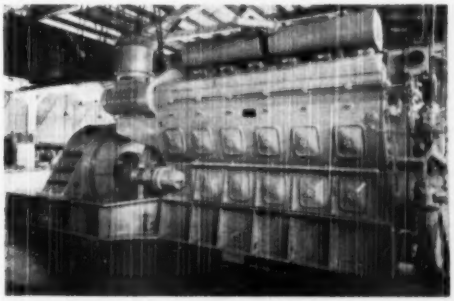
Turbo-Generators
Condensing
Non-condensing
All Capacities

We Specialize in SUGAR MILL PAPER MILL TURBINES

ALWAYS GET CHARLES WEAVER'S PRICES • ALWAYS REAL MONEY SAVERS



1500-KW. West., Cond. 250-psi. 150-SH. 2400-V.. Sur. West. Condenser. Modern. Pass any inspection.



750-KVA., G.M. Diesel-Generator Set. Model 12567: Crocker-Elliott Generator. 2300-v. 480-V. Complete. Same as New.

SEND FOR FREE BULLETIN #425 — WE INVITE CORRESPONDENCE.

WRITE
TELEPHONE
WIRE

CHARLES WEAVER

4145 Penobscot Bldg.
DETROIT 26, MICHIGAN

TELEPHONES:
WOODWARD 1-1340
WOODWARD 1-1341
WOODWARD 1-6038

ANYTHING IN POWER PLANT EQUIPMENT — Send Us Your Requirements.

Behind the word

GUARANTEED

ARE YEARS OF HEMPHILL EXPERIENCE IN SELECTING, REBUILDING AND TESTING UNDER SUPERVISION OF ELECTRICAL ENGINEERS

TRANSFORMERS — 60 Cycle

QU.	KVA	MAKE	TYPE	PH.	VOLTAGES
1	1500	GE	HTI	3	4150/2300
1	1000	GE	Auto	3/2	4150 x 2406
1	1000	GE	Auto	3	3810Y-2300Y
2	750	GE	HTU	3	4150/480
1	500	Kuhl.	OISC	1	4600 x 2300V.
3	400	GE	H	1	6900 x 2250V.
1	300	Pitts.	ODSC	1	7800 x 440V.
3	300	GE	H	1	2400 x 120/240
1	200	Whse.	Auto	3/2	4150 x 2300
1	200	Pitts.	OISC	1	4000 x 110/220
1	200	GE	Auto	3/2	4150 x 2400
1	150	GE	KS	1	2300 x 230
1	100	Pitts.		1	2750 x 110/220
8	100	Wagner	RCKV	1	240 x 120/120
2	100	Whse.	SK	1	4400 x 220/440 Taps
2	100	Newark	Dry	3/2	440 x 220
3	100	GE Pyrn.	H	1	4160 x 220/440
3	100	GE	Auto	1	4150 x 2300
1	100	Amer.	OC	1	15000 x 2300
3	75	GE	H	1	2400 x 220/440
3	75	Whse.	SK	1	2400 x 440
7	50	Whse.	SK	1	13750 x 125/230
11	50	GE	H	1	13750 x 125/216
5	50	Whse. Inert.	S	1	4160 x 120/240
3	37½	GE	H	1	2400 x 120/240
3	37½	AC Dry	AD	1	450 x 120
1	37½	Amer.	RS	1	13800 x 220/440
1	37½	GE	H	1	13800 x 220/460
1	37½	Amer.	OISCID	1	13200 x 220/440
3	27½	GE	Dry	1	440 x 220/110
12	25	Whse.	Dry	1	440 x 220/110
1	25	Maloney	Oil	1	230/460/220/110
2	25	GE	H	1	11800 x 240/460
1	25	Maloney	Oil	1	2400 x 120/240
1	18	GE	K		17500 x 440

A.C. GENERATORS
3 Phase, 60 Cycle

QU.	KVA	MAKE	TYPE	VOLTS	SPEED
1	2500	Whse.		2300	720
1	625	GE	ATB	600	3600
1	375	AC		480	450
1	300	GE	ATB	600	600
1	300	AC		240	3600
1	300	Whse.		240	600
1	225	Whse.		550	514
1	125	GE	ATB	240	600
1	170	Whse.		2200	900
2	50	Whse.		220/440	900
3	44	Columbia		240	1200
1	31	Amer.		120/208	1200
1	18.75	Star		220/440	1800
1	12.5	Whse.		240	1200

D.C. MOTORS

QU.	HP	MAKE	TYPE	VOLTS	SPEED
1	125	GE	RC	230	1700
1	100	GE	LC	230	625
1	80	GE	CDM	230	1750
1	75/100	CW	CMC	230	500/1000
1	75	CW	WP	230	860
1	75	GE	C	230	575
1	50	GE	CD	240	650/1300
1	50	CW	CM	230	700
1	40	GE	LC	230	700/1000
1	35	GE	RC	230	860
1	30	GE	CDM	230	1000/1850

D. C. MOTORS (Cont.)

QU	HP	MAKE	TYPE	VOLTS	SPEED
1	30	GE	RC	230	1150
1	30	GE	RC	230	1100
1	30	GE	C	230	625
1	30	GE	RLC	230	400/1200
1	25	Whse.	SK	230	825
1	25	Whse.	SK	230	600
1	25	Whse.	SK	230	400/1200
1	25	CW	CMC	230	335/670
1	25	Whse .	SK	230	300/1200

MOTOR GENERATOR SETS
3 Phase, 60 Cycle

QU.	KW	MAKE	SPEED	DC	AC
1	1000	Whse.	720	275	2300/4150 Syn.
1	1000	GE	514	600	2300/4150 Syn.
1	500	GE	900	275	2300/4150 Syn.
1	400	GE	900	275	2300/4150 Syn.
1	300	GE	1200	250	2300 Syn.
2	150	GE	1200	125/250	2300 Syn.
1	150	Whse.	600	125	4150 Syn.
1	125	CW	1200	125	2300 SC
1	100	CW	1200	125	220/440 SC
1	100	El. Mach.	1200	125	4150 Syn.
2	75	GE	1200	125	220/440 SC
6	75	GE	1200	60	220/440 SC
1	50	Ridgeway	1200	550	220/440 SC
1	50	Whse.	900	250	220/440 SC
2	40	El. Mach.	1750	125	440 SC
1	35	Ideal	1200	125	220/440 SC

OIL CIRCUIT BREAKERS

1—3000	A GE	15000V	3 pole	FK	130
1—3000	A GE	4500V	3 pole	FK	12
2—3000	A GE	600V	3 pole	K	25
1— 600	Whse.	7500V	3 pole	F	124 A
1— 400	Whse.	3700V	3 pole	O	221

SPECIAL DIESEL

1—300 KW De La Vergne Baldwin 6 cy, 4 cycle, 400 RPM, 125/250V.

SPECIAL

1—120 KW 150 KVA Ames Uniflow 16 x 16 220V, 3 ph, Non-Condensing.

NEW CONTROL

4—150 HP GE CR 7051 Sq. Cage Automatic 440V, 3 ph.

A.C. MOTORS
3 Phase, 60 Cycle
Synchronous

QU.	HP	MAKE	TYPE	VOLTS	SPEED
4	200/100	Whse.		4150	720/360
1	200	El. Mach.		2300	360
1	200	GE	TS	440	257
1	185	GE	ATI	2300	720
1	150	GE	TS	220	1800
2	150	AC		2200	360
1	100	GE	ATI	2200	900
1	70	El. Mach.		2200	180
1	35	GE	ATI	2200	1200
1	20	Whse.		220	1800

SLIP RING

1	2500	GE	MT	6600	257
1	500	GE	MT	2200	720
1	150	GE	IM	440	450
1	100	GE	IM	440	400
1	75	GE	MT	220	1200 Vert.
1	75	GE	MT	440	900
1	60	GE	MT	220	1750
1	60	GE	MT	440	900
1	50	GE	MT	220	1720
1	50	GE	MT	220	1200
1	50	Whse.	CW	220	900
1	50	GE	MT	220	1700
1	50	GE	MT	220	600
1	40	GE	MT	220	1200
1	40	GE	MT	2200	1200
1	40	GE	MT	220	900
1	40	GE	MT	2200	900
1	30	GE	M	220/440	1200

SQUIRREL CAGE

QU.	HP	MAKE	TYPE	VOLTS	SPEED
1	150	CW		2200	1200
1	125	GE	KF	2300	1800
1	125	US		440	1200 Vert
1	100	LA	RY	440	1800
1	100	Whse.	CS	440	1800
1	75	GE	KF	220/440	1200
1	75	Ideal	AT	220/440	1200
1	60	Whse.	CS	2200	900 Vert
1	40	GE	KT	220	1200
1	40	Whse.	CS	220	900
1	40/20	Whse.	CS	440	575/435
1	35	Whse.	CS	2200	1200
1	35	GE	IK	550	600
1	30	GE	KT	220	600
1	25	GE	KT	220	1165
1	25	GE	KT	440	1200

LARGE STOCK OF D.C. MOTORS AND GENERATORS, SWITCHBOARD AND CONTROL EQUIPMENT

JLHC

THIS SEAL IS YOUR GUARANTEE

"FOR POWER"

J.L. HEMPHILL & CO.

1604 53rd STREET, NORTH BERGEN, N. J.

PHONE NEW YORK—LONGACRE 5-3227

PHONE NEW JERSEY—UNION 3-2600

Our 44th Year

WAGNER

Quality and Service

"CERTIFIED REBUILT"

DEPENDABLE ELECTRICAL EQUIPMENT AT LOW COST

MOTORS . . . GENERATORS . . . M-G SETS

PUMPS . . . FANS . . . BLOWERS . . . SPEED REDUCERS

PARTIAL STOCK LISTING—WRITE, WIRE OR PHONE YOUR REQUIREMENTS

M-G SETS

KW	Mfr.	Input V	Output V
500	Whse.	2300 AC	250 DC
300	Gen.Elec.*	2200 AC	250 DC
300	Allis Ch.	2200/4400 AC	250 DC
250	Allis Ch.	4400 AC	1200/240 DC
200	R.dgeway*	2300/400 AC	550 DC
200	Gen.Elec.*	220/440 AC	125 DC
200	Reliance*	220/440 AC	250 DC
150	Gen.Elec.	220/440 AC	125/250 DC
150	Burke*	250/440 AC	250 AC
150	Gen.Elec.*	2300/4000 AC	250 DC
105	Century b.b.	220/440 AC	70 DC
100	Allis Ch.*	220 AC	125/250 DC
100	Allis Ch.	2300 AC	250 DC
100	Gen.Elec.*	220/440 AC	125 DC
75	Star*b.b.	220/440 AC	250 DC
75	Gen.Elec. (2)	220/440 AC	125 DC
50	Whse.	220/440 AC	250 DC
50	Gen.Elec.	220/440 AC	125 DC
40	Northw'n Conv.	220 AC	230 DC
35	Gen.Elec.	220/440 AC	48 DC
32	Gen.Elec.	220/440 AC	180 cycle
30	Gen.Elec.	220/440 AC	250 DC
25	Gen.Elec.	220/440 AC	25 DC
20	Whse.	230 DC	110 AC
20	Star b.b.(2)	220/440 AC	250 DC
15	Gen.Elec.	220/440 AC	125 DC
10	Allis Ch.(2)	220/440 AC	250 DC

*Synch. motor drive.

D. C. MOTORS

HP	Mfr	Type	Volts	Speed
200	Reliance	1970T	230	575/750
150	Cr.Wheeler b.b.	92H	230	1200
150	Cr.Wheeler b.b.	TEFC	230	800
100	Whse.	SK181	230	450/900
100	Gen.Elec.	C	230	575/1000
100	Gen.Elec.	RC36	115	1150
75	Allis Ch.	E-149	230	500
75	Northw'n	K20	230	1750
75	Cr.Wh. New b.b.	CMC-HH	230	1150
60	Gen.Elec.	RC26	230	650
50	Whse.	SK133	230	1150
50	Gen.Elec.	CD115	230	850
50	Gen.Elec. b.b.	CDM	115	1150
40/60	Whse.(2)	SK170	230	500/1000
40	Sprague dyna.	LC	230	750/2000
40	Whse.(2)	SK130	230	950
40	Gen.Elec.	RC13	230	1100
35/50	Gen.Elec.	CD123	230	575/1150
35	Ideal	DV350	230	400/1200
30	Whse.	SK93	230	1750
30	Whse.	S-7	115	900
30	Cr.Wh. b.b.	FH	230	850
25	Gen.Elec. b.b. drip	CDM95	115	1150
25	Gen.Elec.	RC31	230	1150
25	Gen.Elec.	CD85	230	1750
20	Gen.Elec.	RF12	230	40/1600
20	Whse.	SK93	230	1150
20	Gen.Elec.	CD85	230	1150
20	Whse.	SK130	230	500/1500
20	Reliance b.b.	TE	230	850
15	Whse.(3)	SK90	230	525
15	El.Dyn. b.b.	326	230	1750
15	El.Dyn. b.b.	158	230	300/1200
15	Whse.(2)	SK80L	230	1150
15	G.E. TEFC b.b.	CD82	230	1750

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
150	Cr.Wheeler b.b.	TEFC	250	1200
105	Century b.b.	1500 amp.	70	1200
100	Gen.Elec.	RC17	125	1300
100	Gen.Elec.	C	350	750
100	Allis Ch. 3 wire	MCW	120/240	1200
75	Cr.Wh. New b.b.	HH	250	1450
75	Allis Ch.	E	250	750
75	Gen.Elec.(2)	RC36	125	1200
60	Gen.Elec.	RC26	250	850
50	Gen.Elec. b.b.	CDM	125	1450
50	Allis Ch.	E-147	250	850
40	Whse.	SK	250	1150
35	Northw'n	K	125	1150
30	Elec.Prod.	BP	50	1150
25	Gen.Elec. b.b.	CDM95	125	1200
25	Gen.Elec. b.b.	CDM96	25	1200
20	Whse.	SK9	250	1750
15	Star b.b.	SQ	250	1750

EXPLOSION PROOF MOTORS

from 1 to 20 H.P. ..... std. speeds

A. C. MOTORS—25 CYCLE

HP	Mfr.	Type	Volts	Speed
150	Whse.	HF	440	500
150	Gen.Elec.	IK-16	440	750
50	Allis Ch.	ANY	440	750
50	Gen.Elec. int.	MTC5337	440	750
50	Gen.Elec.	I-K	440	750
50	Gen.Elec.	KT339	440	1500
50	Gen.Elec.	KT343	440	750
40	Gen.Elec.	KT527	440	750
30	Gen.Elec.			
15	Whse. TEFC	CS365	220/440	1500

A. C. GENERATORS—60 CYCLE

KVA	Mfr.	Type	Volts	Speed
625	Gen.Elec.	ATB	2300	450
500	Allis Ch.	3 brg.	240/480	360
300	Gen.Elec.	ATBJ	240/480	720
250	Whse.	G	2400/480	600
225	Gen.Elec.	ATB	240/480	600
187	Gen.Elec.(2)	ATB	240/480	900
150	Gen.Elec.	ATB	240/480	900
125	Gen.Elec.	ATB	240/480	900
100	Gen.Elec.	ATB	240/480	1200
100	Gen.Elec.	ATB	240/480	1200
56	Gen.Elec. (2)	ATB	240/480	900
56	Gen.Elec.	ATB	240/480	1200
31	Gen.Elec.	AT17536	240/480	1200
31	Whse.b.b.	G	120/208	1200
25	F.Morse	AB	220/440	1800
25	Whse.b.b.	1 ph.	120/240	900

A. C. MOTORS—SLIP RING

3 Phase 60 Cycle 220 or 440 Volts

Qu.	HP	Mfr.	Type	Speed
1—	600	Gen.Elec.	I-M	360
1—	500	Allis Ch.	ANY	450
2—	300	Allis Ch. 2200V.	ANY	720
1—	300	Gen.Elec. 2200V.	I-M	1800
1—	300	Whse. 2200V.	CW	600
1—	250	Allis.Ch. 2200V.	ANY	514
1—	200	Gen.Elec.	I-M	360
1—	200	Gen.Elec.	I-M-17	600
1—	200	Gen.Elec.	I-M-17A	450
1—	200	Allis Ch. 2200V.	ANY	720
1—	150	Gen.Elec. 2200V.	I-M-16	600
1—	150	Whse.	MW	450
1—	150	G.E. 2200/4000V.	I-M	1200
1—	150	Allis Ch.	ANY	600
1—	100	All.s Ch.	ARY226D	900
1—	100	Allis Ch.	ANY	1800
1—	100	Allis Ch. b.b. NEW	ARY	600
1—	100	Allis Ch.	ANY	720
1—	100	Whse. int.	CI-75vA	720
1—	75	Gen.Elec.	I-M-E13	1200
2—	75	Gen.Elec.	I-M-14	720
1—	75	Gen.Elec. int. duty	MTC5342	900
1—	75	Ideal int.	AVE	1200
1—	75	Gen.Elec.	MT558	600
1—	75	Gen.Elec.	MT337	1800
1—	50	Allis Ch.	ANY	900
1—	50	Howell	SR437	1200
1—	50	Fair.Morse	BV	720
1—	50	Gen.Elec. int.	ITC5013	600
1—	50	Whse. int.	CI	600
1—	50	Gen.Elec.	I-M	720
2—	40	Gen.Elec. int.	MTC5338	900
1—	37	Gen.Elec. int.	ITC	600
1—	30	Gen.Elec.	OMT336	1200
1—	30	Gen.Elec.	MT346	600
1—	25	Whse.	CW	1200
1—	25	Gen.Elec.	MT326	900
1—	25	Triumph	8R	1200
1—	25	Gen.Elec.	I-M	600
1—	25	Gen.Elec. int.	MTC5312	900
1—	20	Gen.Elec.	MT303	1800
12—	10	Reliance New b.b.	AW-324	1800

A. C. MOTORS—SYNCHRONOUS

HP	Mfr.	Type	Volts	Speed
600	Gen.Elec.	AT1	220/440	1800
300	Gen.Elec.	AT1	220/440	720
300	Whse.	G	2300/440	600
300	El.Machy.	late	220/440	514
300	G.E. 2 brg .8 PF	AT1	220/440	600
200	G.E. .8 PF	AT1	220/440	900
150	Gen.Elec.	AT1	220/440	300
125	G.E. spigot ....8 PF	T3955	220/440	1200
125	Gen.Elec.	AT1	220/440	900
100	American b.b.	YGH	220/440	600

A. C. MOTORS—SQUIRREL CAGE

3 Phase 60 Cycle 220 or 440 Volts

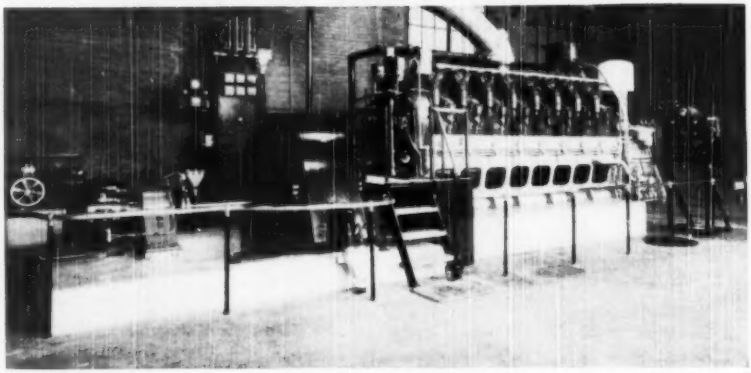
Qu.	H.P.	Mfr.	Type	Speed
1—	400	Whse. 2200V.	CS	1800
1—	250	Gen.Elec.	I-K	1200
1—	200	Gen.Elec.	I-K	900
1—	200	Reliance b.b. NEW	C6085	1800
1—	200	Allis Ch.	AN	1200
1—	150	Gen.Elec.	I-K-16	600
1—	150	Whse. 2200V.	CS771-1C	1800
1—	150	Reliance b.b. NEW	B6085	1200
1—	150	Gen.Elec.	I-K-15	900
1—	125	Reliance b.b. NEW	C5085	1200
2—	125	Allis Ch. 2200V.	AN	1200
1—	125	Gen.Elec.	I-K-16	450
1—	125	Cont. 2200V. b.b.	SC	1800
1—	125	Gen.Elec.	KT339	3600
2—	125	Rel. TEFC NEW	B6085	1800
1—	100	Gen.Elec.	I-K-14	900
1—	100	Gen.Elec.	I-K	1800
1—	100	Allis Ch. 2200V.	AR226	1200
5—	100	Reliance b.b. NEW	C5085	900
1—	100	Elec.Machy.	b.b.	1200
1—	100	Rel. TEFC NEW	C5085	1200
1—	100	Gen.Elec. b.b. NEW	K5048	1800
1—	100	Cont. TEFC	NP682	1200
1—	100	Gen.Elec.	I-K-15	720
2—	75	Gen.Elec.	I-K	600
1—	75	Gen.Elec.	I-K-14	720
1—	75	Reliance b.b. NEW	C5084	900
1—	75	Reliance TEFC NEW	C5084	1200
1—	75	Reliance b.b. NEW	C505	1800
1—	5	Gen.Elec.	KT329Y	3600
2—	75	Reliance b.b. NEW	C505	1200
1—	75	Gen.Elec.	KT347	1200
1—	60	Gen.Elec.	KT552	720
1—	60	Gen.Elec.	KT346	900
2—	60	Reliance b.b. NEW	B504	1800
2—	60	Reliance TEFC NEW	C505	1200
2—	60	Reliance b.b. NEW	C504	1200
2—	60	Whse.H.T.	CS504	3600
1—	60	Wagner b.b.	RP444	1800
1—	50	Whse. b.b. NEW	CS4058	1800
1—	50	G.E. NEW b.b. HT	KG405	1800
2—	50	Reliance b.b. NEW	C445	1200
2—	50	Gen.Elec.	KT336	1200
1—	50	Gen.Elec.	KT342	900
1—	50	Whse. hiclip	WL607	900
1—	50	Whse. b.b.	C5504	1200
2—	50	Gen.Elec.	KT352	600
1—	40	Gen.Elec. b.b.	KF4048	3600
2—	40	Gen.Elec.	KT527	1800
1—	40	Al.Ch. 3 speed	ARX	900/600/450
4—	40	Gen.Elec.	KT336	900
2—	40	Reliance b.b. NEW	C404	1800
2—	40	Reliance TEFC NEW	C445	1200
3—	40	Gen.Elec.	KT532	1200
2—	30	Gen.Elec.	KT342	600
2—	30	Gen.Elec.	KT532	900
1—	30	Al.Ch. TEFC b.b.	ARZ445	900
2—	30	Howell b.b. 4 speed	SC	1800
2—	30	Gen.Elec. NEW b.b.	K365	1800
2—	30	Gen.Elec. NEW hitorq.	KG365	1800
2—	30	Gen.Elec. TEFC b.b.	K404	1800
1—	30	Gen.Elec.	KT326	720
1—	30	Wagner	22T8P	900
1—	30	Whse.	CS846	900
2—	30	Reliance b.b. NEW	C405	1200
2—	30	Reliance TEFC NEW	C444	1200
2—	25	Reliance TEFC NEW	C444	900
3—	25	Reliance b.b. NEW	C364	1800
2—	25	Reliance TEFC NEW	B365	1800
2—	25	Reliance b.b. NEW	C404	1200
2—	25	Reliance TEFC NEW	C405	1200
2—	25	Whse. NEW spl. b.b.	CS365	1800
3—	25	Whse.	CS846	900
2—	25	Gen.Elec.	I-K	600
1—	20	Reliance b.b. NEW	K404	900
1—	20	Gen.Elec. TEFC b.b	K404	1200
4—	20	Reliance b.b. NEW	C364	1800
2—	20	L.A. NEW exp.prt.	EX364	1800
2—	20	Whse. NEW b.b.sp.	CS364	1800
3—	20	Gen.Elec.	KT312	1200
1—	20	Whse.	CS	1200
2—	20	Gen.Elec. NEW b.b.	K365	1200
1—	20	Whse. b.b.	CS326	3600

ARTHUR WAGNER COMPANY

1435 W. RANDOLPH STREET — CHICAGO 7, ILL. — MONroe 6-7409

NO POWER SHORTAGE AT BROCKVILLE, CANADA

DIESEL POWER



DIESEL POWER

Last year the Public Utilities Commission of Brockville, Ontario, was experiencing a serious shortage of power and it became mandatory that a dependable source of power be added immediately. The Commission approached "AGSCO" and purchased the 1000 KW Remanufactured GMC Diesel Unit which is pictured above. This unit was shipped, installed and "on the line" in 58 days, a record of which to be proud.

Other power users in this region were also short of power and large "AGSCO Remanufactured Diesels" were installed for Kellogg Co. at London, Ont.; York Knitting Mills, Toronto, Ont.; Canadian Steamship at Montreal, Ont.; Utilities Commission of Woodstock, Ont. and City of Orillia, Ont.

Select dependable AGSCO Remanufactured Diesels for your power requirements today.

Save on Initial Acquisition Costs with "AGSCO REMANUFACTURED DIESEL EQUIPMENT"

UNITS AVAILABLE FOR IMMEDIATE SHIPMENT

KVA	MAKE	MODEL	HP	RPM	KVA	MAKE	MODEL	HP	RPM
1875	Fairbanks Morse	33F16	2000	300	312.5	General Motors	8-268A	450	1200
1420	Fairbanks Morse	38D	1600	720	312.5	Clark	MD-4	375	327
1250	General Motors	16-278A	1600	720	300	Fairbanks Morse	YVA	360	257
1250	Nelseco	6M1-53	1500	300	250	General Motors	8-268A	350	1200
1000	General Motors	12-278A	1200	720	200	Buckeye	80	240	600
937.5	General Motors	12-567	1080	720	187.5	Ingersoll Rand	S	225	514
625	Alco	6-12-½x13T	750	600	156	Buckeye	E	190	400
425	Baldwin	VO	510	450	125	General Motors	3-268A	150	1200
400	Buckeye	80	480	600	121	Fairbanks Morse	32E14	140	300
375	Enterprise	DSG-6	450	450	75	General Motors	6-71	90	1200
330	Superior	KNA	396	514	62.5	Int'l Harvester	UD-18	76	1200
312.5	Cooper-Bessemer	FSN6	375	900	50	General Motors	4-71	60	1200

"SPECIALISTS IN DIESEL POWER"

Engineered AGSCO DIESEL POWER

A. G. SCHOONMAKER Company, Inc.

ESTABLISHED 1895

Diesel Engines • Power Machinery

52 CHURCH STREET, NEW YORK 7, N. Y. PHONE Digby 9-4350

Reliably Rebuilt Electrical Equipment

41st YEAR

FEBRUARY SPECIALS — SLIP RING MOTORS
2—500 HP G.E.—3 ph., 60 cy., 2300v. 450 RPM
1—400 HP West.—3 ph., 60 cy., 2300v. 514 RPM
All with primary oil switches and magnetic secondary controllers.

Rebuilt — 1 YEAR GUARANTEE
PARTIAL LISTINGS ONLY

MOTORS
Squirrel Cage 3 Phase

H.P.	Make	Type	Speed
500	West. (2)	CS	1160
450	G.E.(vert.)	KF-6338	1180
300	G.E.	IK	900
250	G.E.	FT	3560
200	Wagner	RP2	1750
200	G.E.	KF-6335	880
150	West. (2)	CS	1750
150	West.	CS	580
125	Al.Ch. (2)	AR	435
100	Wagner New	XP	1150
100	G.E.	K-544	1175
100	West.	CS	870
100	G.E. (2)	IK	575
75	West.	CS	1750
75	G.E. (3)	K-505	1175
75	G.E.	IK	900
75	G.E. (3)	KT-352	865
75	West.	CS	720
75	G.E.	K-356	690
75	G.E.	KT-558	880
60	F-M	Tot. Enc.	1800
60	West. (2)	CS-607	880
60	Rel. (2)	AA	875
60	G.E.	KT-346	865
50	G.E.	FTR-523	3500
50	Elliott	196	3450
50	West.	CS	1740
50	L.A. (3)	XP	1150
50	West.	XP	1150
50	G.E.	KF-445	1170
50	West.	CS-642C	1160
50	West. (3)	CS	870
50	G.E. (2)	IK	870
50	G.E.	FTR-542	870
50	West.	CS	690

MOTORS
Slip Ring 3 Phase

H.P.	Make	Type	Speed
600	Cr.Wh.	131AQ	507
500	GE(2)	IM	450
400	West.	CW	514
225	Wagner	25 cy.	710
200	G.E.	MTP-557	1800
200	G.E. (2)	IM	1170
150	Wagner	31VRN	900
150	G.E.	MT-564Y	580
100	G.E.	MT-553	1165
100	Al.Ch.		690
65	West.	CW	1150
65	G.E.		690
50	West.	HP	850
50	Al.Ch.		690
50	G.E.	MT-536	1150
50	West.	CW	1150
50	G.E.	MT-336	1150
50	L.A.	OGH	870
50	F-M	BV	600
50	Al.Ch.	ARY	575
50	G.E.	IM	490

MOTORS
Synchronous

H.P	Make	Type	Speed
475	West.		720
400	G.E. (2)	TS-9288	600
300	G.E.	ATI	900
260	G.E.	TS	900
200	G.E. (2	25 cy.	500
200	Ideal	SMW	257
180	G.E.	ATI	900
160	G.E.	TS	1200
145	G.E.	ATI	720
135	West.	G	1200
135	Ideal		1200
100	G.E.	TS	1200
55	El.Mchy.	BRKT	1200

MOTORS
550V. D.C.

H.P.	Make	Type	Speed
765	G.E. (6)	MPC	1045/1350

MOTORS
230V. D.C.

H.P.	Make	Type	Speed
400	A-C		415
135	C-W	CCM152H	233/900
125	G.E.	RC-15	
100	G.E.	RC-14	
100	Al.Ch.		1150
90/45	G.E.	RF-17	950/475
75	Sprague		1000/1500
75	West. (2)	SK-180	475
75	Cr.Wh.	LT	480/670
75	Cr.Wh.	CMC	375/695
75	West.(3)	SK151	250/1000
60	West. (3)	SK-160	680
50	G.E.	RC-12	1750
50	Diehl		850/1050
45/90	G.E.	RF-17	475/1950
50	West. (3)	SK-160	565
50	G.E.	RF-17	250/1000
50	West.	SK	250/1000
40	West.	SK-103	1750
40	Century	DN-454	1740
40	G.E.	RC-31	1700
40	G.E.	RC-32	1100
40	G.E.	RC-34	750
40	G.E. (2)	CD-1441	400/1500
40	Cr.Wh.	CCM	700
40	Rel.	461T	400/1200
35	West.	SK-120	1150
35	G.E.	RLC	440/800
30	G.E. (8)	CDM-85	2200
30	West.	SK	975
30	Cont.	D-103	850
30	G.E.	RC-33	775
30	West.	SA	500/1500
30	West. (2)	SK-143	575
25	G.E.	RC-15	1750
25	West.	SK-83	1750
25	G.E.	*CDM-77	1750
25	E.D.	10S	1500
25	Rel.	92T	1150
25	West.	SA	500/1500
25	West. (2)	SK-130	600
25	G.E.	RF 14	300/1200

MOTORS
115V. D.C.

H.P.	Make	Type	Speed
300	West.	SK	900
100	Cr.Wh.	CMC	900
40	G.E.	CD-113	850
30	West.	S	600
25	G.E. (2)	CD	1800
25	West.	SK-103	1150
25	Cr.Wh.	CCM	750
25	West.	SA	600/1200
15	E.D.	7½S	650/1230
15	Cr.Wh.	CM	650
12½	G.E. (3)	CDM-85	930/1160
12½	G.E.	*CDM-95	930/1160
10	Century	DN-334	1750
10	G.E. (2)	RC	1200
10	Al.Ch.		900
10	E.D.	7½S	425/1700
10	Diehl		230

GENERATORS — A.C.
Driven by D.C. Motors

KVA	Make	D.C. Input	A.C. Output
288	West	115	450
75	G.E.	230	240
50	Star	115	120
35	G.E.	230	220
31	Ideal	115	440
31	El.Mchy.	230	440
18	G.E.	230	120/240
10	Burke	115	120
7½	Hertner	115	440
5	El.Spec.	115	110
1¼	Al.Ch.	230	110

GENERATORS — A.C.

KW	Make	Type	Speed
216	West.	G	900
180	G.E.	ATB	900
100	G.E.	ATB	360
75	G.E. (2)	ATB	1200
50	F-M	GG	1200
15	G.E.	ASI	1200

Frequency Changers and Generators

Size	Make	Output Frequency
150 KW	G.E.	150 cy.
154 KVA	G.E.	150 cy.
50 KW	G.E.	120 cy.
40 KW	G.E.	100 cy.
30 KW	G.E.	90 cy.
15 KW	G.E.	408 cy.
10 KW	G.E.	200/700 cy.
7½ KW	G.E.	408 cy.
3 KW	G.E.	408 cy.

GENERATORS
600V. M D.C.

KW	Make	Speed
400	G.E. (4)	1200
200	Cr. Wh.	900
200	West.	1150
150	West.	1150
60	G.E.	1200
30	Burke	1750

GENERATORS
250V. D.C. Motor Driven

KW	Make	Speed
1000	G.E.	900
500	West.	1100
300	Elliott	1200
300	G.E.	1200
300	Al. Ch.	1200
200	G.E.	1200
150	West.	900
100	Delco	1200
75	G.E.	1200
50	G.E.	1200
40	Rel. (4)	1750
42	ABC (2)	1200
30	G.E.	1200
25	G.E.	1200

GENERATORS
125V. D.C. Motor Driven

KW	Make	Speed
250	G.E.	720
150	Cr. Wh.	1200
150	West.	1150
100	West. (2)	900
100	G.E.	1200
100	El. Mchy	1200
75	Cr. Wh.	1200
75	Hertner	1150
50	West.	1150
50	Cr. Wh.	1150
50	Sturt.	2800
35	Ideal	1200
30	G.E.	1150
30	L.A.	1450
25	El. Mchy. (2)	1150

GENERATORS
Low Voltage D.C.

Amp.	Make	Voltage
4000	Chandy.	6/12
5000	Optimus	6/12
1500	H-V-W	6/12
125	Hobart (8)	7½
1000	G.E.	15
750	Master	20
1500	Century	24
3000	El. Prod.	24
550	Col.	27
100	G.E.	30
1000	G.E.	33
150	Watton	40
200	G.E.	42
1500	G.E.	50
1500	Century	60
1500	G.E.	60
1000	G.E.	75

TRANSFORMERS

4—333 KVA Moloney, 2300/4600V. Primary, 230/460V secondary.
1—300 KVA, Al. Ch. 3 ph, 4160V. Primary, 230V. Secondary.
1—300 KVA, Pittsburgh, 3 ph.
1—300 KVA, Pittsburgh, 3ph, 4160 V. Primary, 230V. Secondary.
8—100 KVA West. 3 ph. 440-220 Dry.
2—50 KVA G.E.—1—KF, 2400/4160V—120/240V. Sec.
4—25 KVA West. 440V. Primary, 110/220V. Sec.
3—15 KVA West. 440V. Primary, 110/220V. Sec.
60—Additional Oil and Insulated Dry-type Transformers in stock, not listed, down to 1 KVA.

STARTERS — A.C.

1—450 H.P. West. magnetic reduced voltage (550V.) Synch.
2—400 H.P. C-H Bulletin No. 9976, 440V. magnetic reduced voltage Synch.
1—250 H.P. C-H Bulletin No. 9580, 4150V.
1—200 H.P. G.E. CR-7065, 440V. Synch.
3—150 H.P. G.E. CR-7061, 220V. Synch.
2—100 H.P. C-H full voltage Synch.
40—C-H and A-B, 2 and 4 speed magnetic starters.
635—7½ H.P. C-H 440V. magnetic starters.

STARTERS — D.C.

1—600 H.P. 230V. West. magnetic.
150—New 230V. D.C. magnetic starters, from 5 H.P. to 75 H.P., C-H, G.E., etc.
100—New 230V. D.C. manua starters from 1 H.P. to 5 H.P.—G.E. and C-H.
40—New 7½ H.P 230V. magnetic reversing.
1—300 H.P. West. 230V. magnetic.
Over 250 additional D.C. starters in stock, not listed, all size and voltages.

EST. 1910 — L. J. LAND INC. — 40th YEAR

156 GRAND STREET — Phone CAnal 6-3976 — NEW YORK 13, N. Y.

ELECTRICAL EQUIPMENT — REBUILT and GUARANTEED

MOTORS—GENERATORS—MG SETS—TRANSFORMERS—CONTROLS

PROMPT SHIPMENT — PARTIAL LISTING

VARIABLE VOLTAGE DRIVES

40 HP Reliance Variable Voltage Drives, each Consisting of:
1—40 KW 250 Volt, Induction M-G Set, with two auxiliary 5 KW generators and exciter.
1—40 HP 400/1500 RPM, Frame 385T, 230 Volt, DC Motor.
With full magnetic control providing leg forward, leg reverse, run, fast, slow, and stop, and motor operated field rheostat.

SLIP RING MOTORS—3 Ph., 60 Cy.

Qn.	H.P.	Speed	Volts	Make	Type
6	7½	810	550	G.E.	MTC-5201
2	10	1140	440	West.	HF-7A
2	10	570	220	G.E.	HI-11
2	11‡	820	550	G.E.	ITC-5008
2	15	1160	440	West.	CW-464C
2	15	570	220	West.	CW-646
1	18	680	440	West.	MW-316
1	20	860	440	West.	CW-638
1	25	1130	550	G.E.	MT-333
2	25	850	220	Wagner	BR
2	25	720	440	Wagner	22VBB
1	30	865	440	West.	CW-646
1	30	870	440	G.E.	MT-332
1	30	675	440	G.E.	MT-536
2	35	690	440	F-M	HW-H16A
2	40	865	2200	A1-Ch.	ARY-323C
1	40	560	440	G.E.	MT-346
2	50	1150	440	G.E.	M-536
1	50	860	440	West.	HF-12A
1	50	570	440	G.E.	MT-552
5	52‡	850	220	G.E.	IQC-5013***
1	60	685	440	West.	CW-758
1	60	570	550	G.E.	MTC-5546
1	60	345	550	West.	CW-938
1	80‡	575	440	G.E.	MTC-5352
2	125	430	440	G.E.	IL-16
2	150	1750	440	G.E.	MTP-540
1	175	505	550	West.	CW-1002
2	200	600	550	G.E.	IM-17
1	200	495	2200	G.E.	IM-17A
2	300	900	440	G.E.	IM-17
2	300	880	2200	G.E.	IM-17A
4	350	1775	2300	G.E.	IM-E15A
2	350	880	2300	G.E.	IM-17A
1	400	505	550	West.	CW
1	650	1770	440	G.E.	IM-E15C
1	650**	300	440	G.E.	MT-442T
1	700	735	4000‡	West.	CW

220 volt motors can be reconnected for 440 volts.
‡ Intermittent rating. *** 2 phase.
** New. ‡‡ 25 Cycle.

A.C. GENERATORS — NEW

3 Phase, 60 Cycle, 0.8 P.F., Two Bearing, with Damper Winding and Direct Connected Exciter.

Quan.	KVA	RPM	Make	Volts
4	18.7	1800	Columbia	240/120
5	18.7	1800	Columbia	208/120

230 VOLT CONST. SPEED D. C. MOTORS

Qn.	H.P.	Speed	Make	Type
10	3	850	Reliance	Y-32T
25	3½	850	West.	SK-30
1	7½	1150	G.E.	CDM-65
3	7½	850	G.E.	CD-75
10	10**	1750	Kimble	BA-324
3	10**	1150	A1.-Ch.	EB-30
2	10	850	West.	SK-83
10	13½**	600	West.	SK-93
3	15	1750	G.E.	CD-75
5	15	825	West.	SK-90
1	20	1750	L.A.	ONA-L351
1	20	1750/1310	West.	SK-83
2	20	1150	G.E.	RC-30
11	20	750	West.	SK-110L
2	25	825	West.	SK-120
1	30	1100	G.E.	RC-12
1	40	1700	West.	SK-103
1	40	750	G.E.	RC-34
1	50	750	West.	SK-150
1	50	650	G.E.	RC-16
1	80	1750/1310	West.	SK-143
3	150	700	A1.-Ch.	
2	200	1150	G.E.	RC-38
1	250	1150	C.W.	CMC-101A

230 VOLT ADJ. SPEED D. C. MOTORS

Qn.	H.P.	Speed	Make	Type
6	5/7½	600/1800	G.E.	RA-30
1	10	400/1800	Reliance	T-92T
2	10/15	600/2400	Reliance	T-92T
1	12½	280/840	West.	SK-130
10	12½**	600	West.	SK-93
1	15	400/1200	West.	SK-100L
1	20	500/1500	G.E.	RF-11
1	20/25	400/1600	Reliance	T-23-T
1	20/25	300/1200	West.	SK-153
1	25	400/1600	G.E.	RF-13
1	25	500/1500	G.E.	RF-12
1	28/29	300/1200	G.E.	RF-13
1	30	400/1200	West.	SK-163
1	30/40**	400/1600	G.E.	CD-1236
1	35	500/1500	West.	SK-143
1	40/50	400/1200	Reliance	T-4611
1	75	500/1500	Cr.-Wh.	CCM
1	75	375/750	Cr.-Wh.	CMC-125H
3	100	225/900	G.E.	MPC-A
5	100	400/1200	A1.-Ch.	
1	100	320/960	West.	SK-200
1	125	450/1080	West.	SK-190
1	175	330/700	West.	SK-220
2	375	350/500	G.E.	MPC

**New

SQUIRREL CAGE MOTORS—3 Ph., 60 Cy.
Totally Enclosed Fan Cooled, Ball Bearing

Qn.	H.P.	R.P.M.	Volts	Make	Type
1	2	3480	220	G.E.	K-225
2	5	1750	440	L.A.	JA-254
10	5	1730	440	G.E.	K-254
2	5	1165	440	L.A.	JA-284
5	7.5	1740	440	G.E.	K-284
1	10	3480	440	West.	CS-324
1	10	1140	440	Wagner	CP2-326
1	10**	880	220	West.	CS-365-EXPF
1	15	1745	440	West.	CS-328
1	15	1175	440	L.A.	JA-365
1	20	1760	220	G.E.	K-364
1	20	1760	220	G.E.	K-365
1	25	1200	550	G.E.	K-405
1	25	1170	220	L.A.	JX-405
1	25	705	440	West.	CS-W504
1	40	3585	440	G.E.	KP-4058

Splashproof, Ball Bearing

Qn.	H.P.	R.P.M.	Volts	Make	Type
23	5	1750	440	L.A.	FS-254
1	5	1735	220	G.E.	K-254
1	5	1160	440	L.A.	FX-284
1	10	3480	440	G.E.	K-324
1	15	1175	440	L.A.	JA-365
4	15	1150	440	L.A.	FX-365
2	40	1175	220	G.E.	K-445
3	50	1760	440	L.A.	FX-445A
5	50	1160	220	G.E.	K-504
1	125	1770	440	L.A.	FX-1078T
1	150	1775	440	L.A.	FX-1168
3	150	880	440	L.A.	FX-1368
1	150	700	440	G.E.	KP-6335
1	200	885	440	L.A.	FS-1378

Open Type Motors

Qn.	H.P.	Speed	Volts	Make	Type
1	15	3485	220	Reliance	AA-B3247
5	15**	1735	440	Century	SC326
1	15	1200	220	G.E.	KT-502
1	15	900	220	G.E.	FTR-513
1	20**	3475	220	West.	CS-326
5	20**	1750	440	Wagner	RPI-364
1	20	1750	220	West.	CS-W384
1	20	1200	220	G.E.	KP-512
2	20	1160	440	West.	CS-464C
2	20	900	220	G.E.	FTR-522
1	25	1800	220	G.E.	KT-512
5	25**	1740	440	Century	SC-364
1	25	1160	440	West.	CS-467C
1	25	900	220	Howell	SCRB-356***
2	25**	875	440	Master	PR-405
2	25	575	440	G.E.	KT-542
3	30	3550	550	G.E.	K-364S
1	30	1160	440	West.	CS-844
1	30	870	220	West.	CS-846
1	40**	3545	220	G.E.	KF-4048
2	40	1750	440	West.	CS-583C
2	40	900	2300	G.E.	FTR-536
2	50**	1750	440	Master	PR-405
1	50	850	220	West.	CCL
3	60**	1750	440	Ideal	AH-444
2	60	900	440	G.E.	KT-346
1	75	1160	440	West.	CS-662C
1	75	870	220	West.	CS-746A
2	75	865	2300	G.E.	KT-352
1	100	690	220	West.	C
1	100	580	2200	G.E.	IK-15A
2	100	500	2200	West.	CS-930
1	100	495	2300	A1.-Ch.	AN
2	125	435	440	A1.-Ch.	AN
2	125	400	2300	G.E.	I-17-FR
1	200	580	550‡‡	G.E.	KT-568S
2	300	587	2200	West.	CS-39A
1	400	1165	2200	G.E.	IK-E15R
1	500	1200	440	G.E.	KTP-547
1	700	1800	2300/4000	West.	CS-4-39D-12

220 volt motors can be reconnected for 440 volts.
** New. *** 2 Phase. ‡‡ Reconnectable for 440 volts.

G. E. DYNAMOMETERS
Cradle Type, with Control and Dial Scale
(Write for Complete Specifications)

Qn.	HP	D.C. Volts	RPM	Type
1	50/75	250	1650/4000	TLC-20
2	100	250	1650/3600	TLC-50
1	200	250	1200	C

MOTOR GENERATOR SETS
125 and 250 Volts D. C.
(Write for complete Specifications)

KW	Make	RPM	D.C. Volts	A.C. Volts
2	Cont.	1750	125	220/440
7.5**	West.	1455	125	380/220§
10	West.	1750	125	220/440
10	West.	1450	125	220/440†
10	West.	1150	250	220/440
15**	G.E.	1800	125	220/440
15	G.E.	1755	250	220/440
15	West.	1450	125	220/440§
10	West.	1750	125	2200/440
20	West.	1750	250	220/440
25	G.E.	1800	250	220/440
25	G.E.	1200	125	220/440
30	G.E.	1800	250	220/440
30	A1-Ch	1750	125	220/440
50	West.	1750	250	220/440
50	G.E.	720	125	220/440†
75	G.E.*	1200	125	220/440
75	G.E.	1200	250	2300/440
100	Columbia*	1200	250	2300/440
150	West.*	1200	250	2300/440

Note: 3KW, 5KW & 7.5 KW, 250 V. Stds Avail.
** New * Synch. Motor Driven. § 50 Cy. † 25 Cy.

Above Items Represent a Partial Listing Only. Your Inquiries Will Receive Our Prompt Attention. All Equipment is Located in Our Cleveland Warehouse. We Have Controls for Most Items Listed.

ELECTRIC GENERATOR & MOTOR CO.
4521 HAMILTON AVE. CLEVELAND 14, OHIO

1—Fairbanks-Morse and Co., 6 cylinder, Model 32-E-14, 450 HP, 300 RPM, Diesel engine, S/N 87610. Equipment direct connected to 300 KW, Type TGZP, Frame VI, 375 KVA, 80% P.F., 240 volt, 3 phase, 60 cycle, 300 RPM, 903 Amps, Fairbanks-Morse alternator. Fairbanks-Morse V belt driven exciter, Type DG, Frame LA-326, S/N X70134, 10 KW, 125 volts. With panel board on which are mounted:

1 G.E. air circuit breaker. Type AL2-50, 600 volt, 60 cycle, 1000 Amp, 3 poles, 1 Burlington regulator, size GB4B, G.E. 0-300 scale volt meter, G.E. 0-1500 scale ammeter.

PORTER
ELECTRIC COMPANY, Inc.
116 THIRD AVENUE, NORTH
MINNEAPOLIS 1, MINNESOTA
LINCOLN 7531
Electrical Equipment Coast to Coast

TRANSFORMER BARGAIN

OISC Outdoor Type, 60 cycle, Single Phase, G.E., West., Wagner, etc. CSP and conventional Types, Steel and Cast Iron Tanks. Some New
2400 Volt Primary—110/220 Volt Secondary
120 — 1½ KVA
42 — 2 KVA
134 — 3 KVA

For Amazingly LOW PRICES Write, Wire or Phone
Electric Equipment Company
Rochester 1, New York
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STEEL STORAGE TANKS
2—1000 & 2—10,000 Bbl. New Vertical
6—74,000, 55,000 & 37,500 Bbl. Vert.
8—25,000 Gal. Cap. Horizontal
50—10,000 & 3—20,000 Gal. Horizontal
6—10,000 & 12,000 & 16,000 Gal. ⅜" Shell
20—10,000 Gal. Cap. 60 lbs. Press. Test
L. M. STANHOPE, Rosemont, Penna.

FOR SALE
150 HP FYNN WEICHSEL SYNCHRONOUS MOTOR
900 RPM, 3 phase, 440 Volts 60 cycles. Complete with control equipment.
ELECTRIC APPARATUS REPAIR COMPANY
1400 No. 6th Street, Phila. 22, Pa.

ELECTRICAL CABLE
- for every industrial and power application
- Special constructions. Odd lengths.
- Large stocks on hand of high voltage, lead covered cables not ordinarily stocked by your regular suppliers.
- Cut to length. Reasonably priced.

UNIVERSAL WIRE AND CABLE CO.
2668 N. Clybourn Ave., Chicago 14, Ill.

GLOW

SQUIRREL CAGE MOTORS

HP	RPM	Volts	Make
750	900	6600	Westgh
350	3550	2200	Westgh-CS
300	1800	440	Al-Ch
300	900	440	GE-I-17
300	514	440	GE-I
250	1200	440	GE-KTR
250	600	2300	Triumph
225	514	440	GE-I-14
200	490	2200	GE
200	600	440	Westgh-CS
150	600	2300	GE
125	3600	220/440	Al-Ch AN
125	1200	440	Century
125	340	220	A-C
100	1200	2200	Al-Ch AR
85	3600	2200	GE
75	1200	2200	GE-KT
75	1200	220/440	GE-K505Y
75	900	2300	GE
60	3600	2300	GE-KT
60	1800	440	Lincoln
60	1800	2300	GE-FTR
50	3600	440	R & M
50	1800	220	Triumph
50	1200	220/440	GE-Tri-Clad
50	900	220	GE
50	720	2300	Wtg-CS
40	1200	550	A-C AN
40	900	2300	Wtg-CS
40	900	220	Lincoln
40	720	440	GE-KT
35	1800	220	GE type I
35	900	440	GE type I Form M
30	1200	dual	Master
30	900	220	Lincoln
30	900	220	Wagner (Hi-Torque)
30	720	220	GE-HJ
30	514	440	Stanley
25	3600	dual	L-A
25	1800	220	L-A, HD
25	1200	220	Wesche
25	1160	208/416	Wtg-CS
25	900	440	GE
25	690	220	Westgh, type CS
25	575	220	GE-type M

ENCLOSED SQUIRREL CAGE

HP	RPM	Volts	Make
125*	1200	440	GE-TE-FC-BB
75	1200	2300	GE-TE-FC-BB
60	900	440	GE-TE-FC-BB
50	900	440	Reliance, TE-FC-BB
20	3600	dual	Master-TE-FC-BB
20	1200	440	Wagner
20	900	440	GE-TE-FC-BB
15	1200	220/440	Delco-TE-FC-BB
15	900	440	GE-TE-FC-BB
10	3600	220/440	F-M
10	1200	440	GE-TE-FC-BB
7½*	1800	dual	Wagner-TE-FC-BB
7½*	1800	dual	Master-TE-FC-BB
7½	1200	dual	GE-Hi Slip-TE-BB
7½	1200	dual	Delco
7½	1090	220/440	GE-Hi Slip
7½	900	dual	Delco-TE-FC-BB
5	3600	dual	Delco-TE-FC-BB
5*	1800	dual	Master-TEJ-C-BB
5	1800	220	Wagner-TE-B-BB
5*	1200	dual	GE-TE-FC-BB
3	3600	dual	Delco-TE-FC-BB
3	1800	dual	Delco-TE-FC-BB
3	1200	440	GE-TE-FC-BB
3	900	dual	Delco
3	1800	dual	Delco-TE-FC-BB

*New Motor

ENCLOSED SQUIRREL CAGE Cont'd.

HP	RPM	Volts	Make
2	1200	220	GE-TE-BB
2	900	220	Wagner-TE-BB
1½	1800	dual	L Al-TE-BB
1½	1200	dual	Delco-TE-FC-BB
1½	900	dual	Delco-TE-FC-BB
1	3600	220	Haskins-TE-FC
1	1800	dual	Master-TE-FC-BB
1*	1800	dual	Delco-TE-BB
1	1200	220	GE-KT
¾	3600	440	Delco-TE
¾	1800	dual	Wesche-TE-BB
¾	900	dual	Delco-TE-FC-BB
½	1800	440	Delco-TE-BB
½	1800	dual	Delco-TE-BB

SLIP RING MOTORS

HP	RPM	Volts	Make
500	900	440	GE-3 Brg
400	1200	2300	Al Ch
375	1800	2300	Al Ch
350	900	2300	Westgh
300	720	2300	Al Ch
250	720	440	GE-MT
250	300	2300	Al Ch
235	1800	220	GE-I
200	1800	440	Al Ch
150	1750	440	GE-MT
75	1800	220	GE
75	900	440	Al Ch, ANY
75	720	2200	Wagner type BR
60	1800	dual	Al Ch
60	900	2300	Burke
60	900	220	Wesche
50	1800	220	GE-MT
50	900	2300	Ridgeway
50	900	440	Wagner
50	720	440	Al Ch
40	1200	220	GE-MT-338
40	900	220	A-C
40	720	2300	Wtg-HF
40	720	220	Al Ch-ARV
40	600	2300	Al Ch-ARV
40	600	220	Al Ch-ARV
40	450	220	Triumph-C
35	900	2200	GE
35	900	220	Al Ch
35	900	2300	Ridgeway
35	720	220	GE
35	570	450	GE-I
30	1800	2300	Wtg-CW
30	1800	2300	GE
30	1200	440	Wagner
30	900	220	GE-MT
30	600	220	F Morse-BV

VERTICAL MOTORS

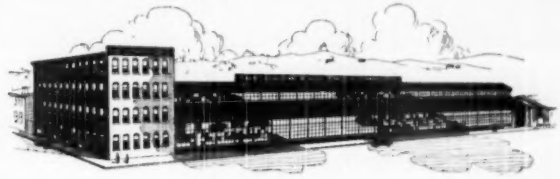
HP	RPM	Volts	Make
200	1200	440	Al Ch-8R
150	1200	2300	GE-I-8R
150	1200	440	GE-Cage
125	1200	2300	Al Ch-8R
125	1200	2300	Al Ch-Cage
100	1200	440	GE-Cage
75	1200	2200	GE-Cage
75	360	220	Ideal-Cage
60	1800	230 DC	GE
60*	1200	440	Al Ch-C

VERTICAL MOTORS—Cont'd.

HP	RPM	Volts	Make
50	1200	2200	Wtg-Cage
50	600	440	Al Ch-Cage
40	1800	220	GE-Cage
40	1700	230 DC	GE
40	1200	440	GE-8R
40	1200	2200	Westgh-BB-Cage
35	1200	2300	Al Ch-Cage
35	450	440	GE-Cage
30	1200	dual	Wtg-Cage
25*	1550	230 DC	GE
25	1200	2200	GE-Cage
25	850	230 DC	Wtg.
20*	1200	440	Al Ch-Cage
20	800	230 DC	GE-RC
15*	1800	440	Al Ch-Cage
15	1750	110 DC	Wtg
15	1150	230 DC	GE
13	600	440	Al Ch
12½	900	220	L Al-Case
10	3400	230 DC	Wtg
7½	1800	500 DC	Peerless
7½	900	440	Burke
7½	700	230 DC	GE
6	850	110 DC	Rel.
5	1400	115 DC	R & M
5	600	440	GE-Cage
4	1650	110 DC	Watson
3	3600	dual	Delco
3	1700	230 DC	Watson
3	1200	dual	Wtg-Case

SYNCHRONOUS MOTORS

HP	RPM	Volts	Make
3000	720	4800	GE-ATI
1015	500	2200	Wtg-25 cycle
710	720	13200/6600	GE
500	514	440	GE
435	720	2300	GE type ATI
320	900	2300	GE-ATI
250	1800	2300/4150	GE-ATI
250	225	2200	GE-TS
225	900	4100	GE-ATI
220	600	2300	GE-ATI
200	225	2300	Wtg, rotor & stator only
175	225	230	GE-TS (rotor & stator only)
160	800	440	GE-ATI
160	164	480	GE-TRF (rotor & stator only)
160	1800	2200	GE
150	1800	220	GE-ATI, single bearing
150	720	440	Westgh
120	225	230	E-M, rotor & stator only
115	164	208	GE
100	1200	220	Wtg single bearing
95	1200	220	Burke
75	1200	220	Westgh
75	900	2300	GE-ATI-7552
60	360	2200	GE, rotor & stator
50	1200	440	Wagner
50	900	220/440	Wesfield
50	720	440	GE-TS
50	360	440	GE, rotor & stator
50	300	220/440	Wtg, (rotor & stator only)
30	900	440	Wagner
30	600	550	GE, rotor & stator
30	450	dual	Wtg, rotor & stator
30	360	550	GE
30	327	220	E-M, rotor & stator
25	1800	220	Wagner
25	450	220	E-M, rotor & stator
20	1200	440	Wagner
20	900	220	Wtg
20	600	220	E-M, rotor & stator



D. C. MOTORS

115 Volts

HP	RPM	Description
225	750	GE-MPC
50	120	Al Ch
35	975	Northern
30	1800	F-M
30	200/600	Sprague
25	1150	Triumph
25	770	GE-A
20	700	Triumph
20	500/1500	GE-RF11
20	400/1200	GE-RLC fr 202A
18	600	Sturtevant MPB
15	1200	J & L
15	1000	GE-CE
15	975	F-M
15	725	Westgh-8 fr 6
12	1075	J & L
12	530	Westgh-8K-113
10	3450	Imperial
10	1700	Fairbanks-Morse
10	650	J & L, type CI
10	400/1600	Watson-BW15B

GEAR HEAD MOTORS

60 Cycle, A.C.

HP	Output RPM	Volts	Ph	Description
20/10	375/185	440	3	Master-Two speed motor
10	450	220/440	3	Master-Vertical
5	6850	220/440	3	Master-Parallel
5	200/1800	220/440	3	Delco-Variable Speed Transmission
3	300	220	3	GF-Parallel
3	215/1500	3	3	Master-Vari-Drive
2	315	220/440	3	Master, Parallel
2	261	220/440	3	Master, Parallel
1½	5.4	220	3	Janette, Rt Angle
1½	388	110/220	1	Master, Parallel
1	420	220/440	3	Master, Parallel
1	2.2 to 11	220/440	3	U.S. Varidrive
1	190	115/230	1	Master, Parallel shaft
½	107.8	220/440	3	Janette, Rt Angle
½	148	220	3	Master, Rt Angle
½	190	220/440	3	Master-Parallel Shaft
¼	99	220/440	3	GF-Rt Angle
¼	260	440	3	Janette-Parallel Shaft
1/8	19	220/440	3	Master, PA-TE-BB
1/12	172.5	115	1	Wstgh Rt Angle

D. C. GENERATORS

125 Volts

KW	RPM	Description
540	1000/1300	Westgh, single bearing
500	750	GE-MCF
300	1500	GE-CC
200	900	GE-MPC
200	800	GE-DMC
100	1000	WE-DLC
100	900	Westgh-8K single bearing
55	1000	GE-Type TD
40	600	J & L-F Fed Type
35	1165	GE-DLC
31.25	1400	Westgh-8K single bearing

D. C. GENERATORS

230 Volts

KW	RPM	Description
400	1200	Westgh, single bearing
200	1200	GE-MPC single bearing
175	450	Westgh
50	1200	Al Ch-E-127
35	1800	GE-RC
30	300	Triumph
22½	765	Westgh-8K
20	1750	Delco Ballbearing
15	300	Burke
15	350	Westgh 8K

AC & DC MOTORS • GENERATORS • PUMPS
SYNCHRONOUS MOTORS • CONTROL EQUIPMENT
MOTOR GENERATOR SETS • ELECTRIC EQUIPMENT
STEAM ENGINE GEN. SETS • SLIP RING MOTORS

ELECTRIC CO.

927 HARRIET ST.
PHONE MA. 3024
CINCINNATI 3, OHIO

BREW-WOLTMAN OFFERS

TURBINE UNITS

1—12500 KVA Al. Ch. Cond. 60 cy. 6900 V. 250-lb. 900 deg. Surface Condenser.
1—12500 KVA Al. Ch. Cond. 60 cy. 13800 V. 240-lb.
1— 9375 KVA Cond. 60 cy. 13800 V. 600-lb. 825 deg. Surface condenser & Boiler. NEW.
1— 5000 KVA G. E. Non-C. 60 cy. 13200 V. 600-lb.
1— 3125 KVA Worthington Non-C. 60 cy. 2300 V. 150-200 lbs., 40 lbs. BP.
1— 2500 KVA G. E. Extraction Cond. 60 cy. 480 V. 185-200 lbs. steel valve chest.
1— 1563 KVA G. E. Extraction Cond. 60 cy. 480 V. 200-lbs.
1— 1250 KVA DeLaval Non-C. 60 cy. 2300 V. 230-lb.
1— 1250 KVA Allis Cond. 60 cy. 2300 V. 150-200 lb.
1— 940 KVA Elliott Cond. 60 cy. 480 V. 400-lbs.
1— 937 KVA Al. Ch. Extraction Cond. 60 cy. 480 V., 150-200 lbs.
1— 125 KVA West. Non-C. 60 cy. 240/480 V. 150-lb., 5 lb. BP
1— 25 KW Allis Non-C. DC 125 V. Exciter Dual drive turbine & motor.

BOILERS

2—1400 HP B. & W., 650 lb., 700 deg.
1—1000 HP Comb. Engr. 250-lb., 490 deg.
2— 500 HP B. & W., 200-lb., 488 deg.
2— 500 HP Sterling 180-lb. Coal & Oil.
2— 253 HP B. & W. 225-lb. Bent tube.
3— 250 HP Titusville 125-lb. Fire box.
2— 200 HP Erie Economic 125-lb. Stokers.
1— 180 HP Frost 200-lb. Return tubular.

DIESEL ENGINE UNITS

2—1650 HP Fair. Morse 60 cy. 2300 V. NEW gen.
2— 900 HP M.A.N. 2300 V. 60 cy. NEW.
1— 720 HP Amer. Loco. 240 V. DC.
1— 600 HP Fair. Morse 2400 V. 60 cy.
1— 400 HP Fair. De La Vergne 2400 V. 60 cy.
2— 240 HP Fair. Morse 2400 V. 60 cy.

STEAM ENGINE UNITS

1—1125 KVA Nordberg Uniflow, 480 V.
1— 312 KVA Skinner Uniflow, 480 V.
1— 250 KVA Ames Vertical Uniflow, 480 V.
2— 187 KVA Ames Vertical Uniflow, 240/480 V.

NEW MOTORS STOCK 20-200 HP

SYNCHRONOUS MOTORS—60 cy.

2—3000 HP G. E. 2300 V. 257 RPM
1— 880 HP G. E. 6600 V. 514 RPM
1— 600 HP G. E. 440 V. 360 RPM
2— 500 HP E. M. 2200 V. 514 RPM
1— 350 HP G. E. 440 V. 900 RPM
2— 350 HP G. E. 2300 V. 257 RPM
1— 300 HP G. E. 2300 V. 600 RPM
1— 300 HP West. 2300 V. 900 RPM
1— 200 HP G. E. 220 V. 600 RPM

INDUCTION MOTORS—60 Cy.

1—3000 HP Cr. Wh. S/R 2200 V. 885 RPM
2— 450 HP West. S/C 4150 V. 300 RPM
1— 300 HP West. S/R 2200 V. 1770 RPM
1— 250 HP G. E. S/R 2200 V. 1800 RPM
1— 200 HP E. M. S/C 480 V. 1800 RPM
1— 200 HP Cr. Wh. S/C 2300 V. 720 RPM. NEW.
1— 200 HP G. E. S/R 2200 V. 435 RPM
1— 150 HP Cr. Wh. S/C 440 V. 1800 RPM. NEW.
1— 150 HP Cr. Wh. S/C 440 V. 1200 RPM. NEW.
1— 150 HP Cr. Wh. S/C 440 V. 900 RPM. NEW.
1— 75 HP Al. Ch. S/C 440 V. 900 RPM.
3— 75 HP Cr. Wh. S/C 220/440 V. 1200 RPM

MOTOR GENERATOR SETS

2—1500 KW West. 250 V. DC 60 cy.
2—1000 KW G. E. 600 V. DC 60 cy.
1— 750 KW G. E. 275 V. DC 60 cy.
2— 300 KW G. E. 250 V. DC 60 cy.
1— 75 KW Star 240 V. DC 60 cy.
1— 75 KW West. 125 V. DC 60 cy.

ROTARIES—60 Cy.

1—2929/3705 KW Gen. Elec. 225/285 V.
1—2160/2700 KW Gen. Elec. 240/300 V.
2—2000 KW Gen. Elec. 600 V.
1—1000 KW Westinghouse 600 V.

MERCURY ARC RECTIFIERS

2—4500 KW Multi Anode 600 V. DC
2—3250 KW Ignitron 650 V. DC
1—1850 KW Ignitron 275 V. DC

FREQUENCY CHANGERS

1—12500 KVA G. E. 25/60 cy. 300 RPM
1— 2500 KVA G. E. 25/50 cy. 300 RPM
1— 1250 KVA West. 25/60 cy. 300 RPM
2— 1000 KVA G. E. 25/60 cy. 300 RPM
1— 500 KVA Al. Ch. 25/60 cy. 300 RPM

TRANSFORMERS—60 Cy.

1— 333 KVA West. 132000—7620/13200
1—2000 KVA G. E. 69000—13800/23900, 3 ph.
3—1000 KVA West. 66000—11000
3—1000 KVA West. 66000—7200
1—5000 KVA West. 34500—13750, 3 ph.
1—5000 KVA G. E. 33000—2300/4000, 3 ph.
1—3000 KVA West. 33000—2300/3800, 3 ph.
6— 50 KVA G. E. 33000—2300
6— 75 KVA Moloney 33000—2300/6000
3—3750 KVA West. 26400/13200—2400
4— 450 KVA Al. Ch. 25410/44000—13280/23000
3—1000 KVA Pittsburgh 22800/11000—2200
1— 750 KVA G. E. 13200—480, 3 ph. Unit. Sub.
2— 200 KVA G. E. 11500—220/110
3— 200 KVA Moloney 11000—2300
1— 167 KVA G. E. 7200/12400—240/480
1—1500 KVA West. 4000—2300, 3 ph. Auto
3— 250 KVA Al. Ch. 2300—460
3— 500 KVA Pittsburgh 2300—230/460
3— 20 KVA West. 2200—575/287½
12— 15 KVA Standard 450/225—117/234
2—27½ KVA G. E. 440—220/110

OIL CIRCUIT BREAKERS

1— 600 A. 73 KV G. E. FHKO-138 Outdoor
1— 400 A. 37 KV G. E. FHKO-136-CS Outdoor
1— 400 A. 37 KV Condit FO-48-B Outdoor
2— 400 A. 37 KV West. G-11 Outdoor
1—1200 A. 34.5 KV G. E. FKO-339-1000 Outdoor
1—1200 A. 25 KV G. E. FHKO-256 Outdoor
4—2000 A. 23 KV G. E. FKO-339-1800 Outdoor
4— 600 A. 15 KV G. E. FHKO-138BB Outdoor

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Special Offerings

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2—New 4000 KW Cond. 2400 4160 V. 750° T.T.
1—3500 KW 550 V Cond.
1—2500 KW 600 V Cond.
1—2500 KW 2300 V Cond.
1—2000 KW 600 V Cond.
2—1800 KW 2300 V 400#
2—1250 KW 2300 V Cond.
1—1000 KW 2300 V non-C.
1—1000 KW 440 V Cond.
1—1000 KW 480 V Extract 300#
1— 750 KW 600 V Extr.
1— 750 KW 240 V Cond.
1— 600 KW 550 V NC— 70# B.P.
1— 600 KW 480 V Cond.
1— 600 KW 2300 V Cond.
1— 500 KW 2300 V Cond.
1— 250 KW 240 V Non-C.
1— 160 KW 220 V Non-C.

TURBO-GENERATORS (Continued)

1— 150 KW 2300 V Non-C.
1— 125 KW 600 V Extrac.
1— 100 KW 600 V Non-C.

TURBINE—Only

1—New 465 HP—3550 RPM 900 PSI.

WATER-WHEEL GENERATORS

2—250 KW Vert. 21' Hd. 3 ph. 60 cy—550 volts

ENGINE GENERATORS

1—850 KW 2300 V Unit.
1—600 KW 2300 V Unit.
1—375 KW 2300 V Unit.
1—168 KW 220 V Unit.
1—168 KW 550 V

BOILERS

2—40,000# 200#
2—30,000# 425#
1— 623 HP 450#
6— 550 HP 200# Sec. Hd.
1— 487 HP 200#
1— 300 HP 200#
3— 250 HP 125# Econ.
2— 220 HP 160# 3 Drum
1— 180 HP 152# H.R.T.

AIR COMPRESSORS

1—6000 CFM 50# Motor
2—2000 CFM 100# Motor
1—1700 CFM 100# Motor
2—1298 CFM 100# Motor
1—6000 CFM 5.1# NEW
1—5000 CFM 10# Rotary Type Motor

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THOUSANDS OF ITEMS IN STOCK
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Air Compressors—Steam Pumps
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Gear Reducers & Transm. Supplies
Condensation Return Units
Steam Turbines & Engines
Hydraulic Pumps & Presses
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EQUIPMENT CO.

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300 KW., 250 volt, Westgh. Ignitron A.C. 3 ph., 60 cy., 2300 v., Bargain

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8403 Hegerman St., Philadelphia 36, Pa.

POWER EQUIPMENT—READY TO SHIP

A.C. MOTORS—3 PH. 60 CY.

No.	HP.	Make	Type	Speed	Volts
1 NEW	200	West.	SYN	1200	220/440
1	250	Burke	SYN	720	2300
1 vert	250	G.E.		1175	2300
1	200	G.E.	I	860	2300
1	200	G.E.	SYN	1200	2200/550
1	175	West.	MS	1200	220/440
1	150	West.	SYN	257	220/440
1	150	West.	SYN	600	220/440
1 NEW	150	Ell. Machy.		720	4160/2300
1	150	West.	SYN	900	2300
1	150	G.E.	I-K	1200	2300/220/440
1	150	West.	MS	1200	220/440
3	150	Louis Allis	FX	1750	220/440
1	125	West.	hi-torq	1115	220/440
4 NEW	125	West.	SYN	1200	220/440
1	125	G.E.	I-K	900	220/440
1 NEW	125	G.E.	TEFC	890	2200/440/220
1 NEW	125	Elec. Mach.		589	2300/440
1	125	Elec. Mach.	SYN	164	220/440
1	125	West.	TEFC	3600	220/440
1	112	West.	SYN	1200	220/440
1	100	Reliance	IT	495	220/440
1	100	G.E.	I	720	220/440
1	100	Al. Chal.		720	220/440
1	100	G.E.	I-K	900	220/440
1	100	G.E.	I-K	900	2300
1	100	West.	hi-torq	830	220/440
1	100	West.	SYN	900	220/440
1	100	Cr. Wh.	SC	1100	2200/220/440
1	100	Louis Allis	OGS	1750	220/440
1 NEW	75	Al. Chal.	AR	865	220/440
1	75	Stanley		600	220/440
1	75	Al. Chal.		580	220/440
1	75	West.	CS-877C	660	220/440
1	75	G.E.	I-K	600	220/440
1	75	G.E.	I-K	720	2200
1	75	G.E.	I	720	220/440
1	75	Louis Allis	OGS	1200	220/440
1	75	Burke		1200	220/440
1	75	Louis Allis	FAA-585Y	1150	220/440
2	75	West.	CS (TEFC)	1750	220/440
1	60	Al. Chal.		515	220/440
1	60	G.E.	I-K	600	220/440
1	60	Cr. Wh.	SC	720	220/440
5 NEW	60	West.	CS-607	900	220/440
		(EXPLOSION PROOF — TEFC)			
1	60	Burke		900	220/440
1	60	Triumph		1200	220/440
1	60	G.E.		1800	550
1	60	Elec. Dyn.	drip pr.	3600	4000/2300
2	50	G.E.	KT-548	720	220/440
1	50	Cr. Wh.		900	220/440
1	50	Wagner	Fynn Weichel	900	220/440
1	50	Triumph	B	850	220/440
2	50	West.	CS	860	220/440
2	50	G.E.	KT	1200	220/440
2 NEW	50	Reliance (TEFC)	B-504-S	1750	2200
3 NEW	50	G.E. (TEFC)	K-504	1750	2200
1 NEW	30	West.	CS-445 hi-torq	900	220/440

SPECIAL BARGAINS

Diesel Engine Generator Sets

10—100 kw., 120/240 v. D.C. Delco Generators dir. con. to 150 HP Model GBD-8, 5½x7, 8 cyl. Superior DIESEL Engines, elec. start with engine panels

4—100 KW same as above with 220 or 440 v. NEW A.C. Generators

1—63 kva. 120/208 v. 3 ph. 60 cy. 1800 rpm., driven by Caterpillar DIESEL mt'd on trailer

2—75 kva. 220/440 v. 3 ph. 60 cy. Delco Cummins DIESEL

2—37½ kva., 220/440 v. 3 ph. 60 cy. Buda DIESEL

10—NEW 37½ kva., 220/440 v. 3 ph. 60 cy. LeRoi Gasoline

1—31.3 kva. 120/208 v. 3 ph. 60 cy. G.E. Gen. driven by LeRoi GASOLINE

11—NEW 25 kva. 120/220 v. 1 ph. 60 cy. LeRoi GASOLINE

1—12½ kva. 120/240 v. 1 ph. 60 cy. 1200 rpm., dir. con. Hercules GASOLINE

4—12½ kva. 120/240 v. 1 ph. 60 cy. dir. con. LeRoi Gasoline Engines

1—7½ kva. 120 v. 3 ph. 60 cy. Wisconsin GASOLINE

6—3 kva. 110/220 v. 1 or 3 ph. Hercules GASOLINE

SLIP RING MOTORS—3 ph. 60 cy.

No.	HP.	Make	RPM	Volts
1	800	Westg.	595	4600
1	400	G.E.	450	2200
1	250	Cr. Wh.	600	440/220
1	100	Triumph	580	550/440/220
1	75	G.E.	1200	220/440
1	60	G.E.	570	220/440
1	60	Westg.	900	220/440
1	60	Burke	1200	220/440
1	50	G.E.	570	220/440
1	50	Allis Chal.	690	220/440
3	50	Westg.	870	2200
1	50	G.E.	900	220/440
1	50/32	G.E.	800/440	220/440
1	30	Elec. Dy	1165	220/440

VARIABLE SPEED MOTORS—230 V. D.C.

No.	HP.	Make	Type	RPM
1	200	Westg.	SK-210	500/750
1	125	G.E.	CD	400/1200
1	100	Westg.	SK-100	580/1000
1	100	G.E.	CD-185	400/1200
1 NEW	60	Westg.	CD	850/1700
1	50	Westg.	SK-170	350/1050

DIESEL & GASOLINE COMPRESSORS

1—315 cfm Ing. Rand portable 100# pres. driven by 105 hp. Waukesha Oil Engine.

1—315 cfm Schramm 100# pres. dir con. Buda Gasoline Engine rubber pneumatic tires

2—105 cfm Penna. 100# pres. driven by Buda Gas Engines

1—195 cfm Ing. Rand portable with Waukesha Engine

A. C. GENERATORS—3 ph. 60 cy.

No.	KVA.	Make	RPM	Volts
1 new	250	Westg.	1200	220/440
4 New	100	West.	1200	220/440
1	100	Elec. Mach.	164	220/440
1	100	Westg.	600	220/440
1	75	Elec. Mach.	900	220/440
10 New	37½	West.	900	220/440
11 New	25	West. (single Phase)	900	120

MOTOR GENERATOR SETS—250 V.D.C.

Motors 220/440 volt or 2200 volt 3 phase, 60 cycle

No.	KW	Make	RPM
3	250	Westinghouse	1200
1	200	Westinghouse	720
2	200	Westinghouse	1200
1	100	Westinghouse	720
1	100	General Electric	900
1	100	Westinghouse	600
1	100	General Electric	1800
1	100	Reliance	900
1	100	Delco	1200
2	90	Westinghouse	600
4	75	Westinghouse	720
1	75	Westinghouse	1200
1	60	Westinghouse	1200
1 NEW	50	General Electric	1800
3	40	Westinghouse	900
2	30	Westinghouse	720

125 V. DC M.G. Sets

1—100 kw. G.E. 125 v. 900 rpm. 220/440 v. 3 ph. 60 cy. AC Syn.

1—75 kw. West. 125 v. 1200 rpm. 220/440 v. 3 ph. 60 cy. Syn.

BRAND NEW TURBO SET

Westinghouse Steam Turbine consisting of 300 kw., 230/460 v., 3 ph. 60 cy. 1200 rpm., 80% P.F. A.C. Generator—40 kw., 120 v. 1200 rpm., D.C. Exciter and Westg. Reduction Gear.—Non-cond.

SPECIAL BARGAIN AIR COMPRESSOR

6—240 CFM Westinghouse type 3 VS-23 3 cyl. vert., 150 lbs. pres. dir. con., to 50 HP., 220/440 or 2200 v. 3 ph. 60 cy. West Slip Ring Motors, auto. control. Can furnish D.C. Motors or Oil or Gasoline Engines if desired.

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New Chrysler Diesel Power Units
75 HP Model IND-3, 6 Cyl., Elec. Start. Includes 4 batteries, Radiator, Spare Parts and Twin Disc Clutch.

Caterpillar Diesel Power Unit
Model D 13000, 6 Cyl., 4 Cy., 900 RPM, 5¾"x6", including Clutch. Rebuilt.

Caterpillar Model D50 Tractor
#1E185, LaPlante-Choate, straight blade, BD 50-28, single action. Overhauled, excellent condition.

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DIESEL GENERATOR SET!

225 HP Busch Sulzer Model DF, 3 cyl., 4 cycle, solid injection, 360 RPM. Direct connected 150 KW 3/60/2300 volt generator with direct connected exciter, air filter, muffler, etc. A modern unit in perfect condition only $4000 f.o.b. St. Louis.

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BOILERS at REDUCED PRICES

IMMEDIATE DELIVERY

Yarrow 3 Drum Bent Tube
Max. Steam per hr. 65,000 lb.
Normal 55,000 lb.
Working Pressure 225 P.S.I.
Test Pressure 387 P.S.I.
Heating Surface 6256 Sq. Ft.

NUMEROUS OTHER ITEMS ARE AVAILABLE FOR INDUSTRIAL USE

Cleaver Brooks
Fire Tube Marine Package Type 60 H.P.
100 lb. Max. Working Pressure
2,000 lb. Steam per hr. at 35 lb. pressure

Wickes Water Tube, 3 Drum
55,000 lb. Steam per hr. normal
65,000 lb. Steam per hr. max.
628 H.P.
Working Pressure, 250 lb.

Babcock & Wilcox Water Tube Boilers
22,500 lb. Steam per hr.
Working Pressure 250 P.S.I.
Heating Surface 4874 Sq. Ft.

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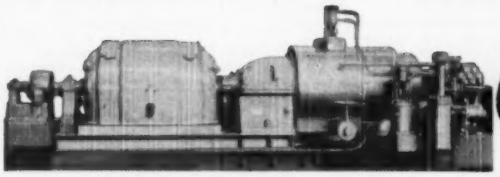


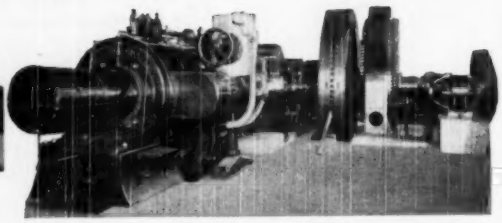
2500 KVA ALLIS CHALMERS CONDENSING TURBO UNIT

2000 KW 80% P.F. 2500 KVA Allis Chalmers Generator, 3 phase 60 cycle 4160/2300/600/480 volts, direct connected to 2000 KW Allis Chalmers condensing turbine, 400# steam pressure, 650° TT, 3600 RPM.

Equipped with direct connected exciter, surface condenser and auxiliaries.

This unit is designed for high efficiency. The full load steam consumption is approximately 11# steam per KW hour.

New 1933—Excellent Condition—Can be shown in operation



750 KVA SKINNER NON-CONDENSING UNIFLOW UNIT

750 KVA Westinghouse generator, 3 phase 60 cycle 2300/-600/480/240 volts, direct connected to Skinner Universal Uniflow non-condensing engine, 150# steam pressure, 5# back pressure, 150 RPM.

Equipped with belt driven exciter, and rheostats.

New 1931—Excellent Condition

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IT'S EMPIRE FOR THE BEST

NEW AND REBUILT ELECTRIC POWER EQUIPMENT

Squirrel Cage Motors—3 Phase

HP	Make	Type	Speed
250(2)	G.E.	KF559	1800
200(2)	G.E.	IK	450
150(2)	G.E.	IK	900
150	West.	CS-856C	900
150(3)	Century	8CN585W	1200
150	West.	CS	1800
150	G.E.	KT547S	1800
150	G.E.	IK	900
125	G.E.	K542Z	1200
125	Century	8CN584W	1200
125(2)	G.E.	K549	1200
125	G.E.	IK	600
100	Al.Ch.		720
100	G.E.	KTP543	1800
100	Cr.Wh.	CW35R	1800
100(2)	West.	CS445	3600
100	G.E.	IK	900
100	G.E.	KG	1800
75	G.E.	FT-537	1800
75	L.A.	FAN-505	1800
75	G.E.	IK	514
75(3)	G.E.	IK	600
75	Fair.M.	BH24A	600
75(2)	G.E.	KT556	720
75(3)	G.E.	IK	720
75	West.	CS	720
75(6)	G.E.	IK	900
75	G.E.	KT552	900
75	G.E.	KT552	900
75(2)	G.E.	KT547	1200
75	Diehl	18178	1200
75(2)	Al.Ch.	AR	1800

Synchroneous Motors—3 Phase

350	G.E.	ATI	600
300	G.E.	TS-974Y	720
220	G.E.	ATI-PB	600
200	G.E.	ATI-6304D	257
150	G.E.	TS-7641	720
145(3)	West.	6C1258	1200
108(2)	G.E.	TS954Y	1200
75(2)	G.E.	ATI-PC	900

Squirrel Cage Motors—2 Phase

50(4)	West.	CS	1200
40	West.	CS	1200
30	West.	CS	720
25	Fair.M.	H12B	900
25	West.	CS	1750

3 Phase—25 Cycle—Motors

200	G.E.	IM	720
150	West.	HF	360
150	G.E.	IK	720
100	G.E.	IM	485
100	G.E.	MTC5353	750
100	Lincoln	IQ	750
100	West.	CS(Gear Hd.)	900
75	G.E.	IK	500
75	G.E.	IK	750
75	West.	CW-773C	750
50	Century	8C50	750
50	Burke	N-505S	1500
40(2)	G.E.	MTC-5333	750

Slip Ring Motors—3 Phase

450	West.	CW	500
300	G.E.	MTC5566Z	600
275	G.E.	I	360
150	Fair.M.	HV-Z20C	1800
125	Al.Ch.	ANY	600
100	G.E.	IM	1800
75	Al.Ch.	ANY	600
60	G.E.	MTC-5546	600
60	G.E.	MT-546	900
52	Otis	35A	720/240
50	G.E.	IM	450
50	G.E.	IM	720
50	G.E.	MT-552	720
50(3)	G.E.	MT-542	900

Slip Ring Motors—2 Phase

150	G.E.	MQP549	1800
52	G.E.	IQC5012	900
50(6)	Al.Ch.	ANY 26C	900
50	G.E.	MQ336 (Vertical)	1200
40	Al.Ch.	ARY	720
30	Al.Ch.	ARY-220C	900
25	Al.Ch.	ARY	600
25	Al.Ch.	ARY 220C	900
25	G.E.	MQ326	1200

230 Volt—DC—Motors

150	Cr.Wh.	83H(TEFC)	900
150	G.E.	CDP125	1800
125	Burke	WAM-15	1200
112(4)	Cr.Wh.	HHL	1750
100	G.E.	CDM1239Y	1200
100	Elec. Dynamic	108M	1800
90	West.	8K-1-83-H	575
62½(3)	West.	8K123L	1750
60(2)	G.E.	CDM-95	1800
59(2)	G.E.	CQ-2007	470
50	West.	CK9	600
50	West.	SK220	94/170
50	G.E.	RLC204	500/1500
50(9)	G.E.	COM1830	525
40	G.E.	COM105	850
40	Cr.Wh.	50H	750/1000
40(4)	Cr.Wh.	FH-M	1800
40	Century	DN454	1800
35	G.E.	RLC	650/1300
30(3)	Al.Ch	E122	850
27½	El.Dyn.	18S	450/1350

115 Volt—DC—Motors

100	G.E.	CDM1242Y	1200
80	Cr.Wh.	CMC-50H	1200
65	G.E.	CDM-1135Z	1200
60	Cr.Wh.	CMC125H	240/300
25	G.E.	RC31B	1200
15	West.	CK7	850
15	West.	SK83	1200
15	G.E.	RC29A	1750
15	Elec. Specialty	U53	1750
15(2)	West.	SK	1750
14/17	G.E.	RA30	1650/2100
10	G.E.	RC29	850
10	G.E.	RC29A	1150
10	West.	SK70L	1750

SPECIAL

A.C. and D.C. NEW MOTORS available at tremendous savings. Large inventory. Immediate Delivery. Ask for our list.

EMPIRE ELECTRIC COMPANY, INC.

87-93 JAY STREET **PHONE MAIN 4-5900** **BROOKLYN 1, NEW YORK**

MOTORS - M.G. SETS - CONTROLS

AT REDUCED PRICES!

M-G SETS

G.E. 600 KW M-G SET
250 volts D.C., 900 RPM, 875 HP, TS, 80% P.F. Syn. Motor. Complete with control. Can furnish for any A.C. voltage.

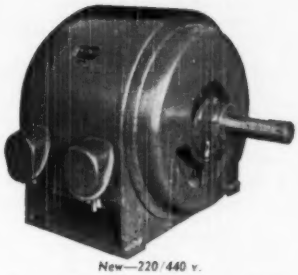
KW	D.C. Volts	A.C. Volts	Mfg.
500	250	2200	C-W
400	125/250	2300	Ideal
300	250	2200	G.E.
300	125/250	440/2300	Allis (New)
200	250	2200	Whse.
200	125/250	2200	G.E.
150	250	440	G.E.
125	250	440	Whse.
100	250	220/440	Star (New)
75	250	440	C-W
60	250	220	G.E.

SYNCHRONOUS

HP	RPM	Volts	Mfg.	Type
800	150	440	G.E.	80%
650	138	2200	Whse.	Engine
600	450	2200	G.E.	80%
500	514	440	E-M	100%
500	600	2300	E-M	80%
400	900	2300	Whse.	80%
400	720	440	G.E.	80%

100 & 125 HP New C-H Manual Compensators, 220 v.

SLIP RING



New—220/440 v.

HP	RPM	Mfg.	Shaft
500	1200	Elliott	4½ x 8"
125	720	Elliott	4 x 12"
100	720	Elliott	4 x 12"

Reconditioned and guaranteed

HP	RPM	Volts	Mfg.
700	720	2300	Allis
500	450	2300	G.E.
450	514	440	Whse.
350	900	2300	Whse.
350	450	2300	Whse.
250	900	440	Whse.
200	1200	440	G.E.
150	900	2300	C-W
125	900	440	Whse.
125	720	440	E-M
100	600	2200	A-C

New 1250 HP 720 RPM G.E. MT 2300/3/60 Slip Ring Motor, with Hyd. Coupling and Magnetic Control.

NEW DIRECT CURRENT

230 VOLTS
Drip proof — ball bearing

Qu.	HP	RPM	Mfg.	Frame
5	250	1750	A-C	149
2	75	1750	F-M	1509
1	75	400/1200	Rel.	651-T
5	30	850/1700	Rel.	230-T
3	10	1750	Rel.	34-T
5	7½	575/2300	G.E.	77-CD

Reconditioned and guaranteed
230 VOLTS D.C.

HP	RPM	Mfg.	Brg.
250	400/1200	E-D	Ball
200	300/900	Whse.	Ped.
200	400/1200	Rel.	Ball
150	350/1200	Whse.	Ped.
150	300/1050	C-W	Ball
125	400/1200	G.E.	Slv.
125	300/900	Rel.	Slv.
100	600/1500	Rel.	Ball
100	500/1500	C-W	Ball
100	475/1350	E-D	Slv.
75	500/1500	C-W	Ball
60	400/1200	Whse.	Slv.
50	350/1050	Whse.	Ball

NEW SLIP RING CONTROLS
12—250 HP 440/3/60 Fully Magnetic, Reversing, 7 steps acceleration, Allis-Chalmers, with air ckt. brkr. Open or enclosed.

Buy from BOSWICK with confidence

WAlbridge 1195

BOSWICK ELECTRIC CO.

P.O. BOX 55 AKRON 9, OHIO

Compressors — Vacuum Pumps

A Good Name to Go Buy

"AMERICAN"

REBUILT — GUARANTEED
Save 40% to 60% One—Two—Four Stage

CFM	Pressure	Make	Model
28.5	250	Worth	BW500
40	500	IR	Type 20
61	1000	Worth	VS
105	350	CPT	T-CB
110	3000	IR	Type 40
140	125	Gardner Denver & Sullivan	WB and WL-80
170			
230			
285			
388	125	Worth	M-75
1055	110	IR	XRE
1280	125	Worth	VD
1452	70	Penn	DBI
2340	125	CPT	W-GE

All Makes — Many Other Sizes
Rentals For Experimental Work
PORTABLES — GAS — DIESEL

American Air Compressor Corp.
Dell Ave. & 47th St., North Bergen, N. J.
— SINCE 1902 —

DIESEL GENERATOR PLANTS

COMPLETE WITH SWITCHBOARDS

1000 KW to 100 KW
STATIONARY and PORTABLE
AT GREATLY REDUCED PRICES
NEW UNIT GUARANTEE

HERCULES ELECTRIC MACHINERY and EQUIPMENT CO.

Tel. NEvada 6-2808
Cable Address HEMCOY

1412 So. Alameda Street
Compton, Calif.

SPECIAL OFFERINGS
3—450# P. 500 HP B&W Stirling Boilers
3—750, 500 & 250 HP Spreader Stokers
1—650 KW Turbo Gen. Set, Cond. or Non-C.
1—2900 Sq. Ft. Wheeler Surf. Condenser
1—10'x170' & 5'x40' Rotary Kilns
1—200 HP, 600 RPM, Slip R. & Sc. C. Motors
H. & P., 6719 ETZEL, ST. LOUIS 14, MO.

SPECIAL TRANSFORMERS — YOUR SPECIFICATIONS

NEW TRANSFORMERS
OIL COOLED
AIR COOLED
PHASE CHANGERS

ARROW TRANSFORMER CO., INC.
1932 E. Westmoreland St., Philadelphia 34, Pa.
GArfield 5-0488

USED TRANSFORMERS
REWOUND
REBUILT
RECONDITIONED

MOTORS • GENERATORS • TRANSFORMERS

MOTORS
3 PHASE—25 CYCLE—220/440 VOLTS

H.P.	Make	Type	Frame	RPM
150	Gen. Elect.	IK-17		365
150	Gen. Elect.	IK-16		430
150	Gen. Elect.	IM-16	Slip Ring	490
150	Allis Chalmers			1450
150	Gen. Elect.	KT	557	1455
200	Westinghouse	CS	2200 volt	1500
350	Westinghouse	CW	Slip Ring	500
500	Gen. Elect.	IK		485
600	Gen. Elect.	MT	Slip Ring	490
600	Westinghouse	CS		490

HIGH FREQUENCY M-G SET

250 KW G.E. single phase 400v., 960 cy., 3600 RPM, direct connected to 375 HP G.E. induction motor 3 ph., 60 cy., 440 v. Complete with motor starting equipment, generator and exciter panel.

350 KW GENERATORS

2—350 KW G.E. generators type MPC, 250 v. D.C. 720 RPM single bearing machines.

DIRECT CURRENT EQUIPMENT

125 or 250 v. motors and motor generator sets in all sizes.

6250 KVA TURBO-GENERATOR

1—6250 KVA Gen. Elect. Unit—Generator 3 Phase, 60 cycle 2300/4160 Volts 3600 RPM.
Complete Installation For Immediate Delivery.

200 HP SYNCHRONOUS MOTOR

200 HP Gen. Elect. Synch. Motor—New 3/60/2300/225 RPM—1.0 PF Engine type with M-G set for excitation and 200 HP Gen. Elec. New Full Voltage Syn. Dead Front Control Panel.

700 KW M.G. SET

3—350 KW Gen. Elect. Type MPC 250 volt, 720 RPM Generators will direct connect to 1000 HP Synchronous Motor or will sell Generators separately.

200 KW M.G. SET

200 KW Westinghouse NEMA Frame Generator 250 Volt DC, 1200 RPM, direct connected to
200 HP Westinghouse Synchronous motor 3/60/2300/1200 RPM, A.C.—D.C. Panels—Like New

Immediate Shipment.

SLIP RING MOTORS
3 Phase—60 Cycle—220/440 Volts

H.P.	Make	Type-Frame	Speed	Remarks
2— 20	LA1	KH	900	
20	G.E.	MT-302	1800	
30	Cr. Wh.		1800	
3— 35	West.	CW	585	
35	G.E.	MT-342	690	
35	West.	MW	690	
40	West.	CW-748A	690	
5— 40	G.E.	MT-326	1200	
40	G.E.	MT-523	1800	
50	G.E.	MT-536	1200	
50	G.E.	MT-537	1800	
2— 50	West.	CW	1800	
60	G.E.	MT-533	1800	
60	West.	CW-653C	1800	
100	West.	CW	425	3 bearing
3—100	G.E.	I form M	900	
2—100	G.E.	MT-747	1800	
125	G.E.	I form M	1200	
2—250	G.E.	I form M-16	900	
350	West.	CW	425	2200 volts
500	Al. Ch.	ANY-WR	514	2200 volts
600	G.E.	MT	490	25 cycle

This motor will rewind satisfactorily to
700 G.E. MT 720

HORIZONTAL & DUPLEX
Compressor & Vacuum Pumps after Coolers, Filters

NEW TRANSFORMERS
Stock Shipment

3—25 KVA Niagara O.I.S.C. 2400/120/240, 1 Phase, 60 cycle, with taps.
6—25 KVA Niagara O.I.S.C. 2400/240/480, 1 Phase, 60 cycle, with taps.
3—37½ KVA Niagara O.I.S.C. 2400/120/240, 1 Phase, 60 cycle, with taps.
6—37½ KVA Niagara O.I.S.C. 2400/240/480, 1 Phase, 60 cycle, with taps.
2—50 KVA Niagara O.I.S.C. 2400/120/240, 1 Phase, 60 cycle, with taps.
6—50 KVA Niagara O.I.S.C. 2400/240/480, 1 Phase, 60 cycle, with taps.
4—75 KVA Niagara O.I.S.C. 2400/240/480, 1 Phase, 60 cycle, with taps.
9—100 KVA Niagara O.I.S.C. 2400/120/240, 1 Phase, 60 cycle, with taps.
5—100 KVA Niagara O.I.S.C. 2400/240/480, 1 Phase, 60 cycle, with taps.
6—150 KVA Niagara O.I.S.C. 2400/240/480, 1 Phase, 60 cycle, with taps.
3—167 KVA Niagara O.I.S.C. 2400/100/240, 1 Phase, 60 cycle, with taps.
3—250 KVA Niagara O.I.S.C. 2400/240/480, 1 Phase, 60 cycle, with taps.
3—333 KVA Niagara O.I.S.C. 2400/240/480, 1 Phase, 60 cycle, with taps.

TRANSFORMERS

3—100 KVA Gen. Elect. Transformers. Type H Form KF—2400/4160 volts primary 120/240 volts secondary. Price $450.00 each. Electrically O.K. F.O.B. truck, Minnesota.
2—50 KVA Gen. Elec. Transformers. Type H Form K—1 Phase 60 Cycle 2300 Volts Primary 115/230 Serial No. 3154838.
3—200 KVA Westinghouse Transformers. Type SK—1 Phase 25 Cycle 2300 Volts Primary 115/230 Volt. Secondary. Serial No. 1214688-90-91.
3—100 KVA Kuhlman OISC 60 cy., 1 phase, 11,000v. primary, 240/480v. secondary.
1— 50 KVA Kuhlman OISC 60 cy., 1 phase, 11,000v. primary, 120/240v. secondary.

FREQUENCY CHANGERS

All Sizes in Stock. 60 cycle to 90 cycle, 100 cycle, 120 cycle, 180 cycle and any other high cycle.

ERIE ELECTRIC CO., INC.

124 CHURCH ST. BUFFALO, N. Y.
CL. 4758

DIESEL GENERATORS
ATTRACTIVELY PRICED

3—G. M. Model 6-71RC, 1200 RPM, 6 cyls., direct connected to 75 KVA Generators 3/60/127-220, complete. New 1946. Only used 100 hours. Guaranteed condition.

DOWTHERM BOILERS

2—Foster Wheeler, 500,000 BTU, 125# pressure, National Board, gas fired.

MOTOR DRIVEN ARC WELDERS
AT 60% LESS THAN NEW COST

300 & 400 amps. G. E. or Hobart, 3/60/220 or 440 Volts.
Rebuilt with new machine guarantee—All current models.

BLOWERS—From 1000 to 80000 CFM.

COMPRESSORS—I.R. Centrifugal, 4 stage, single flow, 6500 CFM, 10#, M.D. UNUSED. Frick, Ammonia, 4x4 Type G.

GAS PURIFICATION SYSTEM—Complete with tanks, valves, piping, Cap. 2000-16,000 cu. ft. horizontal hr.

MOTORS—3—125 HP, 440V., 1750 RPM, TEFC
2— 50 HP, 440V., 1170 RPM, TEFC.
(Other NEW TEFC & X.P. Motors to 7½ H.P.)

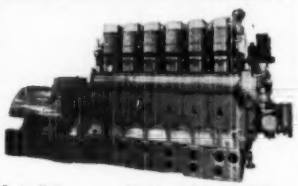
STACKS—5'3"x110', welded, ⅜" & ⅜".
42"x37' high, ¼" & ⅜".

TRANSFORMERS—1 to 1500 KVA, all Voltages.

Heat and Power Co., inc.

70 PINE STREET • DIGBY 8-0373 • NEW YORK 5, N. Y.

ENTERPRISE DIESELS



Quan.	H.P.	Model	R.P.M.	KW	
*2	450	Enterprise DSG-6	450	300	AC,DC
2	1000	General Motors 16-278A	720	1000	AC
2	150	Superior GBD-8	1200	100	DC
2	150	General Motors 3-288A	1200	100	DC
2	150	General Motors 3-266A	1200	100	AC
*2	90	General Motors 6-71	1200	60	AC
*2	90	General Motors 6-71	1200	60	DC
*2	to 20	Kohler 1200/1800 1/3-10	AC, DC		

*New

Diesel Motors CORPORATION

PORT WASHINGTON, L. I., N. Y. TEL. PORT WASHINGTON, 3000

COMPLETE POWER PLANTS
STEAM — ELECTRIC — HYDRO — DIESEL
"Expert Orders Carefully Executed"

BOILER UNITS

1—140,000# New Steam Generator 600#, also Super
2—60,000# Boilers, 625#, 825° F.tt., Economizer and Air-heater
2—60,000# MODERN Boilers 450#
2—50,000 MODERN Steam Generators 450#
3—1000 HP Vogt 300# with Super
2—1040 HP Heine Boilers—Super 200#
3— 750 HP Stirling Type Boilers 200#
1— 400 HP B&W Co. Sectional—Super 200 to 350#
4— 500 HP B&W Sectional Header 200# Boilers.
2— 350 HP Straight Tube 200# Boilers
Also smaller Boilers & Fire Tube Boilers

TURBO UNITS

1—20,000 KW Turbo-Generator—Cond.
1—10,000 KW Turbo-Generator—Cond.
1— 7,500 KW Turbo-Generator—Cond.
1— 5,000 KW Turbo-Generator—Cond.
2— 2,500 KW same as above
3— 2,000 KW same as above } Also 400 & 600# Turbos
2— 1,500 KW same as above
2— 1,250 KW same as above
2— 1,000 KW same as above
1—500 KW same—Also 750 KW & 300 KW Units
Non-Cond.:—300 - 500 - 750 - 1000 - 1500 - 2000

COMPLETE STEAM PLANTS: One with 2-1500 KVA's, One of 2500 KVA & One of 7500 KVA.
Frequency Changers—Transformers! Send us your requirements—We may have it.
Send us your INQUIRIES for ALL POWER MACHINERY

CHARLES B. REARICK 30 CHURCH ST. NEW YORK 7, N. Y.

BOILERS

10 to 1000 H. P.
NEW-USED RECONDITIONED
Steam, Gas and Electric Power Equipment

J. PARKER THOMPSON CO., INC.
507 FIFTH AVE., NEW YORK CITY
MURRAY HILL 7-6547-8-9

WANTED

3—200 Kva 60 cycle single phase transformers, OISC, outdoor type, 6900 volts Primary and 240/480 Secondary.

1—350 HP 550/3/60 squirrel cage motor (550 volts preferred—could use 440). Please quote on starter separately.

3—150 HP 550/3/60 slip ring motors. Please quote on controllers separately.

Please send us your lists of Surplus Machinery. We have been selling:

ELECTRIC AND POWER MACHINERY

here for 39 years. We have a large connection and frequently find an outlet for a machine that would be slow moving elsewhere. We are especially interested in Steam Turbo-Generator Sets, Power House Apparatus, transformers, motors, generators, boilers, HOISTS, fans, Mining Machinery, etc.

Please send us your enquiries—we have surprised many important industries by locating precious machines for immediate delivery at attractive prices. We have frequently supplied equipment that had never been installed before.

FOR SALE

2—1800 Kw 2300/3/60 G. E. Steam Turbine Generator Sets, 3600 RPM, 400 lbs., 100° F. superheat, 2" back pressure.

These have recently been overhauled by the manufacturer—are located in U. S. A. Send for complete details and price. We can also offer many other sizes and types. Please send us your lists.

SOUL CLINIC INC.
CALGARY, ALBERTA, CANADA

EXCLUSIVE FRANCHISES AVAILABLE

For Sale of 10 to 500 H.P. Oil or Gas Fired Automatic Steam Generators.

If you are established in your area and can guarantee active Sales and Service representation and 100% coverage, write us giving full particulars.

AMES IRON WORKS
OSWEGO, N. Y.
Builders of Better Boilers since 1848

FOR SALE

NEW 10 HP GE MOTORS

50% Discount

3/60/220/440/1155 RPM, TE FC BB Model 5K326D160.

GLAZER BROS.—ANDERSON, IND.

two 100 KW 250 Volt DC Generators. Steam driven by Ball Engines—140# pressure.

one 200 KW 250 Volt DC Generator. Steam driven by Ball Engine—140# pressure. Units complete with DC switchboard and two balancer sets.

one 20 ton York Vertical Ammonia Compressor. Steam driven by Corliss Engine—140# pressure.

one 15 ton York Vertical Ammonia Compressor. V belt drive. 33 H.P.—DC motor. Complete with condenser, receiver, valves, gauges, etc.

PURITY BAKERIES
97 E. 12th Street St. Paul 1, Minn.

FROM AVAILABLE STOCK

Rebuilt to N.I.S.A. Standards

MOTOR GENERATOR SETS

3 ph. 60 cycle

Qu.	KW	Make	Speed	D.C. Volts	A.C. Volts
1	1800	G.E.	600	125/250	4000
1	1500	G.E.	600	600	2300/4150
1	1300	G.E.	300	275	2300/4400
1	1250	G.E.	600	275	2300
1	1000	G.E.	720	250	2300/13200
1	1000	Whse	900	600	2300/4150
1	1000	West.	514	250	4150
1	800	G.E.(2U)	1200	130/240	2300
1	750	Whse	900	250	2300
1	500	G.E.	720	600	2300/4150
1	500	GE.	720	125	2300/4000
2	400	G.E.	720	250	440/2300
1	400	G.E.	1200	120/240	440
1	350	G.E.	900	125	2300/4150
1	300	G.E.	1200	250	440
1	150	Cr. Wh.	1200	250	440
1	140(3U)	Cr. Wh.	690	125/250	2300
1	100	G.E.	1170	125	220
1	75	Cr. Wh.	1170	250	220/440
1	75	Cr. Wh.	1200	250	550

ROTARY CONVERTERS

60 Cycle

	Make	Speed	D.C. Volts	A.C. Volts
1—2000	G.E.	514	600	13800
1—2000	G.E.	450	600	2300
1—1000	Whse.	900	600	11000
1— 750	Whse.	900	600	13200
3— 500	Whse.	1200	250	11000

RECTIFIERS

1— 750	G.E.	BHW	575	2300
1—1000	A.C.	B-612	625	13500
1—1000*	A.B.B.	GBZ	625	6600/13200

*This unit with full automatic control good for both 25 and 60 cycle.

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G.E.	Auto Extraction 250# 18P 15# Ext. 2400V, 3 ph. 60 cy.
1	2000	G.E.	Condensing, 175# 18P—6600V, 3 ph. 60 cy.
1	1000	G.E.	Condensing 135/150# 18P 2300/4150 V 3 ph. 60 cy.
2	750	G.E.	Condensing 250/275# 18P 440V, 3 ph. 60 cy. (New 1944)
2	400	G.E.	Condensing, 275# 18P Geared to 1200 RPM. 120/240V, D.C. Generator.
1	300	G.E.	Non-condensing 150/175# 18P 3/15# B.P. 480V, 3 ph. 60 cy.
1	300	Al. Ch.	Condensing 425# 18P Geared to 1200 RPM 120/240V D. C.
	200	Cr. Wh.	Condensing 250# 18P Geared to 1200 RPM—125V, D.C. Gen.
1	200	Whse.	Non-condensing 150# 18P 7# B.P. 240V, 3 ph. 60 cy.

TRANSFORMERS

60 Cycles

Qu.	KVA.	Make	Type	Ph.	Voltages
1	2500	Packard	AT	3	13800 x 2300
1	2500	Al. Ch.	OISC	3	13200 x 2300
3	1000	Pitts	OISC	1	13200 x 2300
3	1250	G.E.	H	1	6600 x 550
1	1050	G.E.	WCTH	3	11000 x 445
1	1000	Maloney	OISC	3	13200 x 480
1	600	Al. Ch.	OISC	3	4000/2300 x 216
3	333	Pitts	OISC	1	26400 x 2600
3	250	Al. Ch.	OISC	1	2300 x 120
3	200	Whse.	OISC	1	7200 x 240/480
6	167	G.E.	OISC	1	2400 x 240/480

D. C. MOTORS

HP	Make	Type	Volts	Speed
1—1750	Whse.		600	525/720
1—1500	Whse.		525	900
1—1200	Whse.		600	425
1—800/1000	Whse.		450	600/720
1—650	G.E.	MPC	250	115/145
1—600	Al. Ch.	MILL	230	400/600
1—300/400	G.E.	DYNA	230	1225/2500
1—335	Whse.	MQ	230	500/900
1—200/300	G.E.	MPC	230	360/920
1—275	Whse.	QM-600-6	230	435/850
1—250	G.E.	MPC	230	400/580
1—230	Al. Ch.		230	700
1—150	G.E.	MPC	230	250/450
1—150	G.E.		600	350/750
10—150	Cr. Wh.	83H	230	800

FREQUENCY CHANGERS

1—2000	G.E.	25/60 Cycle	2300/2300V
1—500	A.C.	25/60 cycle	11000/2300V

A. C. MOTORS

3 ph. 60 cycle

SYNCHRONOUS

HP	Make	Type	Volts	Speed
2—3500	G.E.	ZR	2300	257
1—2100	G.E.	ATI	4000	514
1—2000	Whse.		2300	120
1—1000	Whse.		2300	189½
2— 900	Al. Ch.	(New)	2300	150
1— 650	Whse.	NG	2300	138
1— 600	Whse.	Syn.	440	360
1— 500	G.E.	ATI	480	900
1— 500	G.E.	TS	4150	600
1— 450	Whse.	Sync.	2200	128.5
2— 350	G.E.	TS	2300	150
1— 320	G.E.	ATI	2300	600
1— 300	G.E.	ATI	440	720
1— 300	Whse.		2300	720
1— 300	Al. Ch.		440	600

SLIP RING

1—1000	Whse.	CW	2300	700
2— 700	Whse.	CW	2300	900
1— 500	G.E.	IP	550	565
1— 500	G.E.	1M-Mill	2300	450
1— 500	G.E.	1M	440	595
1— 400	G.E.	MT 413	440/2300	705
3— 350	Whse.	CW	2200	900
1— 350	G.E.	MT-442Y	2200/4000	253
1— 300	Al. Ch.	3 Brg.	2300	505
1— 300	G.E.	1M	440	720
9— 300	Al. Ch.	ANY	2300	798
1— 250	G.E.	MT-424Y	4000	257
1— 250	G.E.	MT-550S	2200	1750
1— 100	G.E.	MT-566Y	440/2200	425
4— 100	G.E.	1M-16	2200	435
2— 100	G.E.	1M	440	600
3— 100	Al. Ch.	AK	2300	1200

SQUIRREL CAGE

1— 250	G.E.	KT-558	440	890
1— 200	G.E.	1K	550	845
1— 200	G.E.	KT-557	440	1800
1— 200/112	G.E.	KP-559BS	440	1170/885
1— 125	Whse.	MS	440	485
1— 125	(New) G.E.	KP-TEFC	440	1190
1— 125	G.E.	KP-TEFC	440	3585
2— 100	Al. Ch.	AR	2200	1170
1— 100	G.E.	1K Vert.	2300	450
2— 100	G.E.	KT-543	220/440	1750

SYNCHRONOUS CONDENSERS

Qu.	Kva.	Make	Type	Volts	Speed
1	5140	Whse.		4150	600
1	4000	G.E.	TSC	2400/4800	900
1	3000	Whse.		4800	750

RENU BILT BELYEA MOTORS

BELYEA COMPANY, INC.

43 Howell St., Jersey City 6, N. J.
Phone: Journal Square 2-3334
N.Y. Line: REctor 2-7150

NEW—TRANSFORMERS—*USED*

Engineered to fit your requirements. Air cooled auto or insulating. 1—400 KVA dry type Class A or Class B. For indoor use. Do not require fireproof vaults

SINGLE PHASE
THREE PHASE

FARATRAN ELECTRIC CO.

PHASE CHANGERS

BIGELOW 3-1773 **21 LEWIS ST.** **NEWARK 3, N. J.**

TURBO GENERATORS

2—1800 KW Rebuilt 400#, 725°, Cond.
1—3500 KW Overhauled, 200# 100° S.H. Cond.
1—2500 KW 250#, 520°, F. with 825 H.P. boiler

Also OTHER Turbines and Boilers.

STEPHEN A. DOUGLAS CO.
630 Ft. Washington Ave., N. Y. 33, N. Y.

80,000 lb. Integral Furnace 400 lb. B & W boiler complete with pulverized coal burners.
1500 KW 2400 volt GE Cond. turbine nozzle (50 lbs. capable changing pressure up to 400 lbs.
285 KVA 240 volt Chase Uniflow engine set.
100 KW 250 volt GE Rotary Converter with 2300 volt transformers.
200-150-100 & 50 KW Syn. M. G. Sets 2200 AC 250 DC

H. BLANE JOHNSON & ASSOCIATES
53 W. JACKSON BLVD., CHICAGO 4, ILL.

SLIP RING MOTORS 3-Ph., 60 Cy.

HP	Volts	Make	Speed
450	440/220	Whse.	514
250	2300/440	Whse.	600
200	440/220	Whse.	514
200	440/220	Whse.	900
200	2300/440	G.E.	1200
200	440	G.E.	450
150	440/220	Whse.	600
150	440/220	Whse. (2)	1800
150	2200/440	G.E.	1200
150	440/220	G.E.	720
100	440/220	G.E.	600
100 (2)	440/220	Whse.	900
100	2200/550	G.E.	1800
80	440/220	G.E. (MTC)	900
75	2200/550	G.E.	1800
75	440/220	Whse. 25 cy.	750

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

HP	Volts	Make	Type	RPM
600	2300/440	G.E.	TS	1200
400	440/220	G.E.	ATI	600
300	2300/440	G.E.	TS	720
300	440/220	G.E.	ATI	600
250	440/220	Whse.	HR	277
250	440/220	G.E.	ATI	600
240	440/220	Whse.	G	1800
200	440/220	G.E.	TS	720
200	4150/2300	Whse.	G	1800
120	440/220	G.E.	ATI	900
110	440/220	G.E.	TS	257
100	440/220	Whse.	G	1800
75	2200/440	Whse.	GE	600

GENERATOR SETS

1—62½ kva. 1200 rpm, 220 volt, Whse., geared to 7200 rpm, Whse., non-cond. steam turbine, 150 lbs. pr.
2—unused 25 kva, 120/208 v., 3 ph., 1200 rpm, generator dir. conn. to Waukesha 6 cyl. gas engine

AIR COMPRESSOR UNIT

1—13" and 8" by 10" Worthington FEATHER-VALVE, 285 rpm, 110 lbs. gs. motor-driven.

CIRCUIT BREAKERS

2—2000 amp., GG E, 3 pole, 600 v., air
2—1600 amp., ITE, 3 pole, 600 v., air
2—1200 ampere, Whse., 3 pole, 600 v., air

SQUIRREL CAGE MOTORS

HP	Volts	Make	Type	Speed
500	440/220	G.E.	IA	900
350	2200	G.E.	KT	1200
300	2200/550	Whse.	CS	1800
250	440	G.E.	KT	900
250	2200/440	L. Allis	OGS	1200
200	440	G.E.	IK	514
200	440/220	Whse.	CS	1200
200	440/220	G.E.	KT	1800
200	2200/440	G.E.	KF	720
200	2200/550	Cr. Wh.	SK	900
200	2200/440	G.E.	KT	1200
200	440/220	G.E.	IK	450
150	440/220	G.E.	IK	450
100	2200/550	Whse.	CS	900
150	440/220	G.E.	KT	720
150	440/220	Howell	B. Brg.	1800
150 vert.	440/220	G.E.	KTP	1200
150	440/220	G.E.	IK	514
125	440/220 (2)	G.E.	IK	514
125 vert.	440/220	G.E.	KTP	1200
100	550	Cr. Wh.	G	900
100	2200/440	G.E.	K	1200

A. C. GENERATORS

1—320 kva. 600 rpm, 2300/440/220 V., G.E.
1—250 kva. 720 rpm, 2300/440 v., G.E.
1—250 kva. 600 rpm, 2200/440 v., G.E.
1—225 kva. 600 rpm, 220/440 v., G.E.
1—210 kva, 1800 rpm, 440/220 V., Whse.
1—100 kva, 1200 rpm, 440/220 V., Whse.

D. C. MOTORS

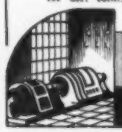
HP	Volts	Make	Type	Speed
250	230 (2)	G.E.	CD	1150
250	230 (2 new)	Cr. Wh.	CMC	1800
200	230	Cr. Wh.	CMC	890
150	230 (new)	Cr. Wh.	TEFC	900
100	230	Cr. Wh.	CMC	635
100	230	G.E.	CD	1750
75	230	G.E.	CD	1150
75	220	Whse.	SK	850

MOTOR GENERATOR SETS

1—300 kw, 1200 rpm, 250 v., G.E., connected to 500 hp, 1200 rpm, 2300/440 v., synchronous
1—165 kw, 1200 rpm, 240 v., G.E., conn. to 250 hp, 1200 rpm, 440/220 v., squirrel cage
1—125 kw, 1200 rpm, 250/120 v., G.E., conn. to 175 hp, 1200 rpm, 4000/2300/440 v., synchronous
1—100 kw, 250 v., Hertner, 1200 rpm, connected to 150 hp, 2200/440 v., synchronous
1—80 kw, 1200 rpm, 250 v., G.E., connected to 135 hp 2200/440 V. squirrel cage motor
1—75 kw, 125 v., 1200 rpm, G.E. conn. to 120 hp, 2200/440 v., syn. motor.

TRANSFORMERS 60 Cy.

3—667 kva, Whse., 33,000—2300 V.
3—400 kva, G. E., 13,800/6900—230/460 V.
3—333 kva, Whse., 4800/2400—240/480 V.
3—250 kva, G. E., 6900/13,800—230/460 V.
3—200 kva, Whse., 13,200—2300 V. (Inerteen)
3—200 kva, G. E., 2400—240/480 V.
3—150 kva, G.E., 2400—240/480 V.
6—150 kva, Al. Chal., 2400—240/120 v.
1—150 kva, Whse. SK, 13200-125/215 v., 3 ph
3—100 kva, G. E., 4600/2300—230/460 V.
3—100 kva, G.E., 13800—230/115 v., NEW
6—100 kva, G.E., 4600/2300-230/115., NEW
3—100 kva, G.E., 450-115/230 v., dry, 1 ph, new
2— 75 kva, G.E., 480—240/120 v. Pyranol
3—50 kva, G.E., 480—240/120 V., Pyr.



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HARRY J. RICE PRES.

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POWER PLANT EQUIPMENT

3—40,000 lbs. per hour B. & W. Type "E"
Boilers, 450 psi; complete plant.

QUICK DELIVERY

For complete description and quotation

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TRANSFORMERS

FOR SALE

2— 150 KVA. 60 CY. 1 PH. 2400-240/480 SCOTT TAPS.
6— 100 KVA. 60 CY. 1 PH. 2400-240/120.
6— 75 KVA. 60 CY. 1 PH. 2400-240/120.
9— 50 KVA. 60 CY. 1 PH. 2400-240/120.
7—37½ KVA. 60 CY. 1 PH. 2400-240/120.
8— 15 KVA. 60 CY. 1 PH. 2400-480/240.

ALSO ALL TYPES OF AIR COOLED AND PHASE CHANGERS.

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asme — BOILERS — nat'l. b'd.

2—406 H.P. Springfield sectional, oil
1—250 H.P. Stirling, Coxe stoker
2—300 H.P. Erie City, oil
2—600 H.P. Stirling type, Spreader stoker
3—84" } Suspended HRT, hand fired
3—72" }

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84-25—81st Street, Jackson Heights, N. Y.

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Power plant equipment. Steam, Diesel, electrical, boilers, engines, turbines, generators, new or used.

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Jackson, Miss.

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New 1943 — Operated to 1945

Shepard-Niles 3 Ton, 230 V DC floor operated hoists. Lift 20 F.P.M. Max. lift 24'.
Hoist motor—4½ HP 1100 RPM.
Trolley Motor—1 HP 1200 RPM.

Completely overhauled

$400.00

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MINNEAPOLIS, MINNESOTA

MODERN DIESEL GENERATING PLANT

300 HP used Fairbanks-Morse Diesel engine, model 32-E-14, serial #785310, direct connected to 200 KW Fairbanks-Morse generator, .8 PF, 3 phase, 60 cycle, 240 volt (can be reconnected to 440 volt). Complete with switch gear, starting equipment, pumps, enclosed cooling system, circuit breaker, silencer and stack.

30 KW new Consolidated portable generator set.

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WATERTUBE BOILERS

IMMEDIATE DELIVERY

1—25,000# 250# PSI
1—15,000# 160# PSI

for SPREADER STOKER or OIL FIRING

Automatic Combustion Eqpt. Co., Inc.
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WAR SURPLUS BARGAINS

120 KVA—460 Volt
3 Phase—60 Cycle

Dykanol
Indoor Dust-Tight—Rack Type
Cornell-Dubilier

CAPACITORS
List Price $1580.00
Now while they last $400.00

Also quantities of 230 Volt and 2300 Volt, single and 3 phase capacitor units in various sizes.

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ELECTRIC COMPANY, INC.
116 THIRD AVE. NO.
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INDUSTRIAL EXHAUSTERS
NEW GARDEN CITY #70

43" 8 blade open paddle wheel impellers, 30" inlet, 21"x30" Discharge, Capacity to 22,000cfm @ 15" w.g., Ideal for Hot Gases to 1600°F., Mechanical Draft, Dust and Material Handling, etc.

Fafnir SAOL 2-15/16" Bearings
Alloy Steel Impellers and Housings
Very Attractive Prices

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P.O. Box 765 **Trenton, N. J.**

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Diesel Gasoline and Steam Generators, Electrical and Industrial Equipment
POWERITE CORPORATION
140 Cedar St. **New York 6, N. Y.**
Dept. 105 **BA 7-8199**

HEINE WATER TUBE BOILER

410 HP straight tube, 200# pressure, new tubes with stoker, blower, soot blowers, Super heater and all trim. Can ship at once.

NATIONAL BOILER & EQUIPMENT CO.
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Used Overhead Cranes
Structural Steel Buildings
Inquiries Invited

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If You Don't Find What You Need Here Wire — Write or Phone

WE CAN SUPPLY IT!

SQUIRREL CAGE MOTORS
3 Phase, 60 Cycle 220 or 440 Volt
(*2200 Volt or Higher)

HP	Make	Type	Speed
750	*G.E.	KT	720
700	*G.E.	WF-56947	1800
600	*Westg.	CS-6-34-15	1200
500	*G.E.	K-559DZ	3600
500	*G.E.	IK	1800
500	G.E.	KTP-567	1200
500	G.E.	IK	900
400	*G.E.	IK	1800
400	*Westg.	CS-936	1800
400	Al. Ch.	ANW	900
400	*Westg. Vert.	CS	720
400	G.E.	IK	600
350	*Westg.	CS	900
350	G.E.	IK	600
350	G.E.	IK-14	514
300	G.E.	FT-559A	1800
300	G.E.	K-559BE	1200
300	G.E.	IK	900
250	G.E.	KT-559	1800
250	*Westg.	CS-8758	1800
250	*G.E.	IK	900
250	G.E.	KT-584	900
250	Westg.	CS	900
250	*G.E.	IK	600
200	*Al. Ch. BB	AR	1800
200	Wagner	26V	1800
200	Westg. BB	CS	1800

SLIP-RING MOTORS
3 phase, 60 cycle
220 or 440 volt
(*2200 volt or higher)

HP	Make	Type	Speed
2500	*G.E.	MT	257
2000	*G.E.	IM	360
1600	*Al. Ch.	ANY	257
1200	*G.E.	MT-26	277
1000	*Westg.	CW-424	500
1000	*Westg.	CW	720
800	*Westg.	CW	507
700	*Westg.	CW	720
600	*G.E. (3 Brg.)	ID	360
600	G.E.	IM	350
600	*Cr. Wh.	RR	514
600	*G.E.	IM	600
500	*Ideal	AV-590	1800
500	*G.E.	IM	720
500	Al. Ch.	ANY	600
500	Westg.	HF	400
500	*Westg.	CW	600
400	*G.E.	MT-412	450
400	*Al. Ch.	ANY	514
400	*Westg.	CW	900
400	*G.E.	IM	900

M.G. SET
1000 K.W., Gen. Elec., type MPC, shunt 275 volt, 3640 amp., direct connected to 1120 K.V.A. Gen. Elec. type TS, 3 ph., 60 cy. 4600 volt, 141 amp., .8 PF, 514 RPM, on fax. sub-base (250 volt fields bus excited)

SYN. A.C. MOTORS
3 phase, 60 cycle
240 or 480 volts

HP	Make	Type	P.F.	Speed
2100	G.E.	ATI	.8	514
1750	G.E.	ATI		3600
1000	Westg.		.8	900
700	G.E.	ATI	.8	720
600	Westg.		1.0	138
400	G.E.	TS-9828	1.0	600
375	Westg.		.8	1200
350	G.E.	TS-7658	.8	900
320	Al. Ch.	Dr. Prf.	1.0	720
300	G.E.	TS-9658		1800
300	G.E.	ATI	1.0	600
250	Al. Ch.		1.0	720

A.C. GENERATORS
3 Phase, 60 Cycle
240 or 480 Volts

KVA	Make	Type	P.F.	Speed
5000	Al. Ch.			450
300	Westg.			200
1500	Westg.			900
1000	Westg.		1.0	900
1000	Westg.		.8	180
875	El. Mach.		.8	212
700	G.E.		1.0	720
360	Al. Ch.		1.0	900
375	Westg.		.8	1200
312	Westg.	3 brg.		600
300	Westg.		.8	900
250	Al. Ch.		1.0	720
150	G.E.	ATI	1.0	600
110	Cr. Wh.	103-8	.8	1200
112.5	G.E.	TS-9548	.8	1200
100	G.E.	ATB	.8	900
60	Fr. Morse	D-D400	.8	300
60	Fr. Morse	R	.8	900
50	G.E.	ATB	.8	1200
50	Westg.		.8	1200

COMPENSATORS
3 phase, 60 cyle

HP.	Make	Type	Volt
300	G.E.	CR-1034	440
200	G.E.	CR-1034	440
150	G.E.	CR-1034	220
150	G.E.	CR-1034	440
125	A.B.	35-3	440
125	G.E.	CR-1034	440
100	A.B.	35-3	220
100	Westg.	A-5	440
100	Al. Ch.	RD-31	2300
100	G.E.	CR-1034	220

BALANCING SETS
34 K.W. 250 volt, 270 amp. neutral Rogue, type MCI, 125 volt generators 3B, comp'd, d/c on fabricated base. 20 K.W., 250 volt, 160 amp. neutral Cr. Wh. type 151, 125 volt generators 3 el. brg. Close coupled—solid comp.

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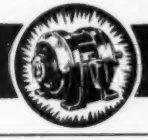

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1320 W. CERMAK ROAD **CHICAGO 8, ILL.**

Vertical Hydro-electric Units

2—500 KVA 3 ph. 60 cy. 2300 v. 225 RPM for 20-24' head
1—250 K.V.A. 3-60-2400 V 150 RPM for 12'-15' hd.
1—225 KW 3 ph. 60 cy. 2300 v. 180 RPM for 18-22' head
1—168 KW 3 ph. 60 cy. 2300 v. 150 RPM for 10-15' head
1—144 KW 3 ph. 60 cy. 550 v. 120 RPM for 9-13' head
1— 80 KW 3 ph. 60 cy. 2300 v. 300 RPM for 12-22' head.
1—1500 KW Vert. unit complete for 50' hd.
2—600 KW units horiz. for 50' hd.

Several horizontal units in good condition priced to sell. All subject to prior sale. We are headquarters for good hydroelectric units. For full particulars write

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MONSON, MASS.

FOR SALE

(1) 500 HP, Allis Chalmers, 440/25 cycle/3 ph. 490 rpm 3 bearing, continuous rated, S.R. mtr.
(1) 550 HP, Allis Chalmers, 2200/60/3/860 rpm, ditto 2 bearing.
(1) 300 HP, G.E., Type I, Form P, 440/60/3/900 rpm, ditto 2 bearing.
(1) 500 HP, G.E., Type I, Form K, 440/60/3/900, squirrel cage, 2 bearing.
(1) 600 HP, G.E., Type I, Form M, 2200/60/3/450 rpm 2 bearing, continuous rated S.R. with full reversing magnetic control for hoist duty.
(1) 400 HP, G.E., MT, 2300/60/3/450 rpm, 3 bearing with control.
(1) 250 HP, Allis, 2300/60/3/580, 3 bearing with control

Many other ratings available. Also some squirrel cage in ratings from 50 to 400 HP.
If any are of interest send your inquiries.

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829 Richmont St., Scranton 9, Pa.
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Most all units still on foundation. Many may be seen operating

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2500 KVA Al. Chal. 2300/4160 v., 400#
1625 KVA Wghse. 2300 v., 150# (bleeder)
1250 KVA GE 480 v., 180# (bleeder)
1250 KVA Elliott 2300 v., 200# (bleeder)
1250 KVA (2) Elliott 480 v., 150/200#
1250 KVA Wghse. 2300 v., 450#
1250 KVA GE 4150 v., 200#
937 KVA Elliott 2300 v., 175# (bleeder)
750 KVA GE 2300 v., 200#
375 KVA Wghse. 220/110 v., 100/125#
375 KVA Al. Chal. 480/240 v., 190#

TURBO UNITS (Non-Cond.)

937 KVA Al. Chal. 480 v., 150#
750 KVA GE 550 v., 70# BP
625 KVA GE 2300 v., 150/200#
250 KVA GE 600 v., 150/200#
62½ KVA; 112 KVA; 125 KVA; 200 KVA and 250 KVA GE 480/220 v. units

DIESEL UNITS

282 KVA Wghse.-GM 240/480 v.
250 KVA (2) Buckeye 2300/480 v.
250 KVA FM 2400/480/240 v.
200 KVA FM-FM: 2400/480/240 v.
156 KVA Ideal-Buckeye 240/480 v.
109 KVA GE-Superior 240/480 v.
75 KVA (2) GM 2400/480/240 v.
75 KVA (2) GM 480/240 v.
37½ KVA GM 240 v.

BOILERS

625 HP Vogt bent tube 450#
600 HP (2) B&W Sec. Header, 200#
540 HP Keeler 250#
490 HP (2) Erie City 3 drum, 160#
400 HP Erie City, Heine type, 200#
350 HP Keeler 2 drum, 160#
250 HP (2) Kewanee fire box 125#
250 HP (3) Titusville fire box 125#
220 HP Union, fire box, steel encased, 150#
150 HP B&W 3 drum, 160#

STEAM ENGINE SETS, A.C.

500 KVA GE-Skinner Unif.
450 KVA GE-Ames Unif. Cond.
400 KVA GE-Erie Ball 4 v.
312 KVA GE-Chuse 4 v.
312 KVA GE-Ames Unif.
312 KVA (2) CW-Skinner Unif.
187 KVA GE-Chuse 4 v.
187 KVA Wghse.-Ames Unif. Ver.
62½ KVA GE-Ames Unif.

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TRANSFORMERS
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POWER PLANT EQUIPMENT CO., INC.

39 Cortlandt St.
New York, N. Y.

FOR SALE

1—Nordberg Uniflow Engine, 14x20, direct connected G.E. Generator, 125 KW, 240/3/60.
1—75 H.P., 440 volt, 3 phase, 60 cycle, 720 RPM, Louis Allis, ball bearing, Squirrel Cage unused motor.

CHARLES V. FISH
501 Commonwealth Bldg., Allentown, Penna.

FOR SALE

Bargain, complete Diesel Power Plant for cheap and emergency power, consisting of 300, 150 and 75 KW; 3 ph.; 60 cy.; 2400 v. units, Fairbanks Morse Modern Unit; Engineering service available.

Diesel, 521 K of P Bld., Indianapolis Ind.
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WANTED

WANTED

SYNCHRONOUS MOTOR

250 or 300 HP, 400 RPM, 60 Cycle, 3 phase, 220 or 208 Volts for direct connection to compressor.

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1658 BROADWAY NEW YORK

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40196 — PHONES — 84548

Air Compressors Wanted

Horizontal Water Cooled—Any size
also 2 Stage portable unit

L. W. BAUER
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WANTED

Turbo-Generator 300-500 K.W., N.C., I.S.P. 350# to 450# B.P. 75# min., 220/440 v., 3 ph., 60 cy., direct or geared. In good operating condition.

M. J. HUNT'S SONS
1620 N. Delaware Ave. Philadelphia 25, Pa.

WANTED

Steam Turbo Unit 4000-5000 KW Marine Type 150 or 200 HP mtr. 3 ph., 60 cy., 720 or 900 RPM 30 & 45 K.V. Insulators

Circuit Breakers 7500 volts 100,000 KVA interrupting capacity or greater.

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1—375 KVA Allis-Chalmers Corliss—220/440 V.
1—375 KVA Ames Vertical 220/440 V.
1—250 KVA Ridgeway four valve 2000 V.
1—187 KVA Ames Vertical 220/440 V.
1—156 KVA Ames Vertical 220/440 V.

STEAM TURBINE UNITS

Complete 2000 KW Turbo-Generator Plant:

1—1500 KW G.E. condensing—3600 RPM
1— 500 KW G.E. condensing—3600 RPM

These units are of modern design, are 3 phase, 60 cycle, 2300 V.

DIESEL GENERATING UNITS

4 Diesel Generating Units, like new, comprising a complete diesel power plant, and consisting of two 450, one 300, and one 150 HP Fairbanks-Morse model 32-E engine-generator units. Engines are of all duplicate cylinder size, 2400/4160 V. 3 phase, 60 cycle. Late model Woodward governors, pumps, cooling tower, etc. Operated only a short time. Available for immediate delivery.

1—250 KVA—220/440 V. G.M. "twin"—NEW—not war surplus.

BEESON ENGINEERING CO.
1628 E. 7th St., Los Angeles 21, Cal.
MUtual 9151

Quality SINCE 1906 **Wente Motors**

WIDE SELECTION UNUSUAL VALUES

THEIR ELECTRICAL CONSTRUCTION HAS BEEN REBUILT . . . BY EXPERTS

SQUIRREL CAGE
3 ph.—60 cy.—220 or 440 V.
(Other voltage as noted)

Qu.	HP	Make	Type	Speed
1	50	G.E.	1 (2200 V.)	900
2	50	Al. Ch.		900
1	60	G.E.	KT	1800
4	60	G.E.	KT (2200 V.)	1200
1	60	Reliance	AA	900
1	75	G.E.	KT	1250
1	100	G.E.	KT (2200 V.)	900
4	100	G.E.	K (TEFCBB)	1200
1	110	G.E.	KTP	1800
1	120	G.E.	PT	3600
2	125	Cr. Wh.	126Q	450
8	125	Al. Ch.	AR	450
2	150	Al. Ch.		1750
1	200	G.E.	I-17	900
1	250	G.E.	KP (Vert.)	3600

SLIP RING—SYNCHRONOUS
3 ph.—60 cy.—220 or 440 V.
(Other voltage as noted)

1	50	Al. Ch.		720
1	50	Ideal	AV	600
1	50	G.E.	I	780
1	60	Ideal	AVX	1200
1	75	West.	CW	600
1	75	G.E.	I	520
1	75	Fair. Morse	HV (2200 V.)	1800
1	100	G.E.	TRB (1.9 PF)	600
1	100	G.E.	I-16 (2200 V.)	450
1	100	West.	CW (.8 P.F.)	1800
1	100	KW G.E.	ATB (.8 PF)	900

Qu.	HP	Make	Type	Speed
1	125	Fair. Morse	T (2400V)(PF1.0)	900
1	150	G.E.	TS (.8 PF)	1800
1	150	West.	CW	450
1	200	G.E.	18C (.8 PF)	600

D.C.—230 Volt
(Other voltage as noted)

1	30	West.	SK	850
1	50	G.E.	CD 1341	500/2000
3	50	Reliance	7	2700
1	50	West.	SK (115 V.)	500
1	60	West.	SK (115 V.)	500/1500
1	75	Diehl	K11	700
1	100	West.	SK	850
1	100	Cr. Wh.	CM	600
1	150	Cr. Wh.	CMC (550 V.)	1200
1	150	West.	SK	850
1	150	Cr. Wh.	CMC	450
2	200	G.E.	TLC-74	1350/4000

M-G SETS

1— 45 KW West. 60 V DC—440 V AC 1200 RPM
4— 60 KW G.E. 60 V DC—440 V AC 1200 RPM
5— 75 KW El. Prod. 230 V DC—440 V AC 1200 RPM
1—100 KW Reliance 230 V DC—220 V AC 1200 RPM
1—100 KW Ridge 230/275 V DC—440 V AC 1200 RPM
1—105 KW Century 70 V DC—440 V AC 1200 RPM
1—150 KW G.E. 230/275 V DC—440 V AC 900 RPM

ALSO—4000 motors other than listed from 1 HP to 200 HP

The Wente Electric Co.,
Hamilton 203 NO. FOURTH ST. Phone 4-8128 Ohio

FOR SALE

7 Panels—Modern G.E. Metal-clad 15 KV switch gear at approximately half price

1000 KW G.E. Turbo unit and condenser

Two 2000 Gal. pumps and motors. 10,000 lbs./Hrs. deaerating water heater

I-R Compressor 20,000 cfm at 100# pressure

Motor-driven Blower—1000 cfm at 4 lbs.

2 motor generator sets 30 KW 125V output

ROOM 4200
316 SOUTH LA SALLE ST.
CHICAGO 4, ILL.

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With all accessories — underfeed, single retort, side dumping.

Width between side walls 6 ft. 6 in. Length from inside front wall to face of bridgewall 6 ft. 4½ in. Equipped with Riley-Jones Riflex Mechanical drive consisting of a highly efficient spur gear reduction unit operating a ram with a simple timing mechanism to vary the interval between ram strokes, thus giving a quick full stroke of the ram at all rates of feed. Stokers are of the unit type driven from fan motor through silent chain drive. This was stand-by equipment and is in excellent condition and available for inspection at warehouse in Bayonne.

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Bayonne, New Jersey

POWER EQUIPMENT
2—3 cyl. 120 HP, 250 RPM, Winton Diesel Eng.
4—Allis Chal. 15 KW 120 V. DC Gen. DC Waukesha Eng.
4—Broderick 125 HP, 325 gal, firebox boilers.
1—150 kva EM 2300 V. AC. Gen. DC Skin. S Eng.
3—150 HP Kewanee 1942 Firebox boilers. Complete.
KINSLOW POWER & EQUIP.
STRODE BLDG., TULSA, OKLA.

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1—600 P.S.I. 740° F. Superheat 150,000 lb. per hour maximum 110,000 lb. per hour normal complete with oil burners.

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Dupont 3388

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for Ventilating, Cooling, Heating, Drying, Blowing, Exhausting etc. Ideal for static resistance applications to 4" W.G. 9 sizes in stock 15"-36"; capacity 2000-30,000 cfm.

VERY ATTRACTIVE PRICES

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Box 765 Trenton 5, N. J.

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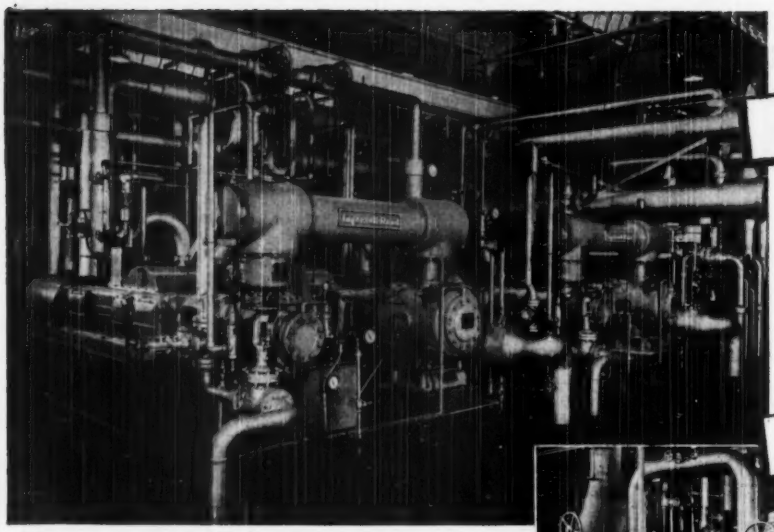
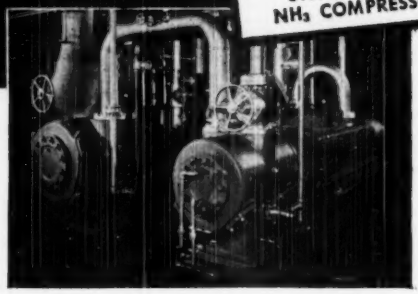


STEAM-DRIVEN CO_2 COMPRESSORS



STEAM-DRIVEN NH_3 COMPRESSOR

At New "DRY-ICE" Plant

PURE CARBONIC

INCORPORATED

Depends on IR COMPRESSORS

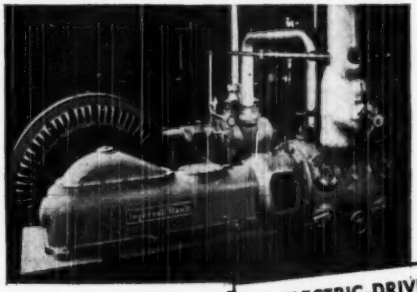
Seven Ingersoll-Rand compressors totalling 1450 hp, in the new Chicago carbon-dioxide plant of Pure Carbonic, Incorporated, help produce 150 tons of "DRY-ICE" daily... for food industries and manufacturers of resins, paints, rubber, plastics, ceramics, pharmaceuticals, petroleum products, and fire extinguishers.

Four 200-hp compressors handle CO_2 gas, compressing it from 35 to 360 psi. These are the well-known Ingersoll-Rand Type XPV steam-engine-driven compressors noted for their simplicity, adaptability to varying conditions, economy, and smooth operation in process service.

One of the ammonia-refrigeration compressors is of the same steam-driven type. The other two, 150 hp each, are of heavy-duty, double-acting, synchronous-motor-driven design.

During the 40 years it has been producing carbon dioxide, Pure Carbonic, Incorporated, has installed Ingersoll-Rand compressors in several of its other plants.

Ingersoll-Rand has had long experience in designing and building process compressors for practically all pressures and all kinds of gases in sizes up to 3000 hp. Qualified compressor specialists are located in I-R offices all over the world. Call upon this experience when you need help in solving a problem of air or gas compression.



ELECTRIC-DRIVEN NH_3 COMPRESSOR

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 457-1

"Ready-made" PIPE HANGER for a "made-to-order" FIT

Look how closely this 8-inch steam main is tucked up under the roof. And, at 410 p.s.i. and 550° F., this piping was bound to move up and down enough to need flexible support. Just the hanger to fit this situation was ready and waiting right in the Grinnell Pipe Hanger Catalog 10-D . . . the Pre-Engineered Spring Hanger fig. B268, type G.

Every pipe suspension problem is pre-solved for you by Grinnell ready-to-install hangers and supports. You can get a copy of Catalog 10-D from your Grinnell branch warehouse or local Grinnell jobber.

100 - ANNIVERSARY
WHENEVER PIPING IS INVOLVED

GRINNELL

Grinnell Company, Inc., Providence 1, R. I. Warehouses: Atlanta • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

You can SAVE MONEY
REDUCE SILICA with the
Permutit® Sludge Blanket Hot Process!

here is a typical case history

A leading paper plant recently installed a Permutit Sludge Blanket Hot Process water softener. The results of several years' operation have been entirely satisfactory. Silica in the boiler feed makeup was reduced to 1/5 the amount previously obtained with a conventional type softener.

Look at the following figures, and you won't wonder that the plant's estimated annual savings on treating chemicals exceeded $6,000!

CHARACTERISTICS	Conventional Design	Sludge Blanket Design
Silica in raw water, as SiO_2 ppm	55	55
Silica in effluent, as SiO_2 ppm	11	2.0
MgO feed, ppm	76	59
Parts SiO_2 removed per part MgO	0.6	1.1
Average retention time of $Mg(OH)_2$ in hours	4.7	100
Contact time of water with $Mg(OH)_2$ in minutes	92	87
Hardness of effluent, as $CaCO_3$ ppm	21	15
Average load on softener, % rated capacity	65	46
Temperature in softener	220°F	243°F

The Permutit Hot Process offers your plant other benefits as well: More efficient use of magnesia! Longer filter runs! Lower turbidity in settling tank effluents! Greater adaptability to flow rate fluctuations! Here indeed is another achievement that spells "Permutit Leadership in Water Conditioning!"

Write for full information to the Permutit Company, Dept. P-2, 330 West 42nd Street, New York 18, N. Y., or to the Permutit Company of Canada, Ltd., Montreal.

For Over 35 Years

Permutit

Water Conditioning Headquarters

Permutit Products for Power Plants

Sludge Blanket Hot Lime Soda Softener (including silica removal) • Zeo-Karb • Hydrogen and Sodium Demineralization combined with Silica Removal • Silica Removal by Hot or Cold Precipitation Processes • Supplementary Chemical Feeding Equipment • Ranarex Mechanical CO_2 Indicators and Recorders • Continuous Blowoff Equipment • Deaerators and Open Heaters